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Passivhaus in the UK: The Challenges of an Emerging Market

A Case Study of Innovation using Mixed Methods Research

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I would like to thank everybody who has helped me with this thesis.

Personal Statement

Henrietta has a multi-disciplinary built environment design background. She has degree and masters level academic qualifications in Fine Art, Architecture, Lighting Design and Environmental Design and Engineering. During her career she has worked with designers, architects and engineers in the UK and Germany. In addition to this she has also taught in UK higher education as a visiting lecturer at the University of Westminster, School of Architecture and the Built Environment (SABE), University College London (UCL) and as a lecturer at The Centre for Alternative Technology (CAT) and at the University of Hertfordshire.

'The principle lesson perhaps being that, while it is all too easy for me to carp on about what is wrong with the Passivhaus standard, or why it is not quite the dog's bollocks (try translating that!), they have built loads of them. And the more they build, the less theoretical it becomes and the more practical it appears. Whereas we may be full of good intentions, the Germans (and the Austrians, who seem to be even more enamoured of Passivhaus than the Germans) have now built around 6,000'

(Brinkley, 2007)

Abstract

In 2006 the UK government announced policy intentions and introduced associated building design standards and up-dated Building Regulations for all new housing to be 'zero carbon' by 2016 and all new non-domestic buildings to be 'zero carbon' by 2019. Since this time the UK build standard for 'zero carbon' compliance for housing is the Code for Sustainable Homes (CSH) and the pre-existing, but evolving, Building Research Establishment Environmental Assessment Method (BREEAM) is the standard for non-domestic buildings.

These standards have been developed by the UK government in conjunction with BRE and other industry consultants to allow building designers to introduce incremental changes to the energy design performance of their buildings. These include for the use of higher levels of insulation (leading towards super insulated fabric design), the use of on-site renewable energy technologies and eventually 'allowable' off-site low energy and renewable energy technology solutions to achieve 'zero carbon' buildings.

Since the introduction of these policy intentions and standards, the UK building design and construction industry has debated both their validity and the actual definition of 'zero carbon', with some believing that a 'fabric first' approach to housing and building design using standards such as the German Passivhaus to be a more effective and simpler way to deliver 'zero carbon' new buildings in the UK.

Despite the fact that many of the technologies leading to the development of the first super-insulated house designs and eventually the Passivhaus standard originated in the USA and UK, (culminating in the construction of a number of exemplar super-insulated homes in these countries from the 1970's), the Passivhaus standard is currently less well known, accepted or understood in the UK than in Norhern Europe. The technology is however beginning to gain credence with a small but growing number of early adopters in the UK.

With a focus on these early Passivhaus adopters, this thesis seeks to identify barriers to the uptake of the Passivhaus standard at the time of this research. The research has been conducted using social science mixed methods research, including for the use of the psychometric assessment tool Q-methodology to assess the opinions of early Passivhaus adopters.

The broad conclusions from this research are that barriers are cultural and linked to both social and technological constraints. These include for understanding of and installation of Mechanical Ventilation with Heat Recovery (MVHR), which is a technology intrinsic to the Passivhaus standard, but also levels of construction industry skills training and education and existing legislation and processes in the UK.

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Synopsis

The Passivhaus low energy building design standard was developed in Germany in the early 1990s. Many believe it to be the world's leading standard for energy efficient building design. It calls for buildings to be constructed with high levels of building fabric performance inclusive of super insulation, low levels of air-permeability, no thermal bridges, passive solar design principles, high performance windows and mechanical ventilation with heat recovery (MVHR).

Since its development, many thousands of Passivhaus buildings have been constructed around the world, the majority of these are in European German speaking countries, but innovators are beginning to work with the standard in the UK.

Test results from buildings constructed to the Passivhaus standard in a number of countries have led many to conclude that the standard represents a model for the basis of the UK government's current '*zero carbon'* building targets. This is due to the fact that these tests have consistently shown that Passivhaus buildings have the potential to reduce overall energy use (and therefore CO_2 emissions) for heating and cooling loads by up to 80% in comparison with buildings constructed to recent building regulations. The aim of this research has been to try and understand some of the context, barriers and opportunities surrounding the emergence of the Passivhaus standard in the UK. This has been through the use of a mixed methods approach to research combining case studies from early Passivhaus developments in the UK and Germany and the analysis of opinions from a large proportion of a small group of early UK Passivhaus innovators using the psychometric assessment technique Q-methodology.

The number of UK case studies used and the number of respondents taking part in this research reflects the small number of Passivhaus developments and Passivhaus innovators at the time of this research. This analysis has aimed to produce a '*snap-shot'* review of current early innovator opinion, and Passivhaus culture in the UK.

Contribution to Research

This research aims to contribute to existing research by helping to provide the following -

- A record of innovator opinion surrounding the early stages of the development of the Passivhaus standard in the UK.
- A record of the early context surrounding the development of Passivhaus standard in the UK.
- An understanding of some of the barriers and opportunities relating to the early development of the Passivhaus standard in the UK.
- An indicative understanding of why the first accredited Passivhaus in the UK was only eventually constructed more than 10 years after the initial 1997 UK CEPHEUS research proposal, and over 30 years since the construction of a number of early super insulated buildings in the UK.
- A contribution to the understanding of the evolution of low energy building design in the UK.
- A potential influence on future policy relating to low energy building design and planning in the UK.
- The use of Q-methodology as part of a mixed methods research strategy for the examination of early stage innovation linked to the built environment and low energy building design.

Introduction

Researcher Values

Having worked in building design consultancy in different roles in both the UK and Germany, I have witnessed two different cultural approaches to the work and legislative environments surrounding building design and construction and building design education in these two countries. This has led me to question some current UK practices and processes and policy surrounding the delivery of the built environment and specifically the delivery of low and 'zero carbon' buildings.

Post 2000 and specifically post 2002, the UK has been on a trajectory to implement legislation and design guidance aimed at the development of low and 'zero carbon' buildings. Since 2006 this has included for a staggered introduction of new iterations to the Building Regulations Part L – *The Conservation of Fuel and Power* and Part F – *Ventilation.* Also since 2006 this has included for the introduction of the Code for Sustainable Homes (CSH). Both the introduction of new building regulations and the CSH have been designed for the eventual delivery of 'zero carbon' buildings, with the intention that all new housing should be designed to be 'zero carbon' by 2016 and all new non-domestic buildings be designed to be 'zero carbon' in 2019. This agenda has involved sweeping changes to building design methodologies including the introduction of carbon as a metric in the determination of building design since 2006.

After having worked with this new UK legislation and design codes on a number of built environment projects and having written an MSc thesis in 2006 titled '*Is Biomass the Answer to PPS22 (Planning Policy Statement 22) in London?*', which critiqued the use of biomass in London to achieve planning and legislatory targets for CO_2 emissions reductions from buildings, I began to believe that there may be better and simpler ways to achieve 'zero carbon' buildings than was/is currently being prescribed in the UK planning and legislatory frameworks.

My experience of working in Germany and contacts with architects in the UK involved with the design of very low energy buildings had made me aware of the German low energy building design standard Passivhaus. The Passivhaus standard seemed to offer a tried and

tested and efficient solution for the delivery of very low and potentially 'zero carbon' buildings. In conjunction with this the standard was specifically developed to provide a generic solution for very low energy homes for the EU (European Union). At the time of the start of this research however, the Passivhaus standard appeared to be virtually unknown in the UK, with no finished accredited examples to examine, despite several early examples of very low energy super insulated buildings having been built in the UK since the 1970s. Taking this into consideration, I set out to try and examine what the barriers to the uptake of the Passivhaus standard in the UK might be through examination of the opinions of early Passivhaus stakeholders and review of early case studies.

Although the German low energy building design standard Passivhaus was originally developed in Darmstadt, Germany at the beginning of the 1990's, it has a history in the evolution of super insulated building design which spans approximately seventy years and extends across continental and national boundaries from the USA and Canada to the UK and Scandinavia. Speculation may tell us that the reason the development of super insulated building design has progressed further in German speaking countries is linked to historical context and concerns surrounding availability of indigenous natural fossil fuel resources compared for example to the UK, but also to increasing concerns raised by environmentally conscious elements of government. It may also be linked to potentially greater values that are placed on skills training and education than in the UK and governance that is arguably more consistent than in the UK**.**

Despite the fact that the majority of buildings designed to the Passivhaus standard are currently located in European German speaking countries, the standard is beginning to gain acceptance with a small group of innovators in the UK.

Through examination of the opinions from a large contingent of this innovation group together with a review of recent UK Passivhaus case studies and early German Passivhaus case studies, this thesis argues that the main barriers to the uptake of the Passivhaus standard in the UK are diverse but rooted in current UK construction culture, or learned specific behaviour. The identification of barriers has also enabled some potential opportunities to be identified for Passivhaus development in the UK.

Research Context

The aim of this research has been to examine the opinions of a small stakeholder group involved in the design of Passivhaus buildings in the UK and compare these to the findings with examination of early UK and German case studies of completed Passivhaus projects.

Given the small group of stakeholders involved with the design of Passivhaus projects in the UK and the small number of completed Passivhaus projects at the time of this research, it was decided to place this research within the context of qualitative research methodologies that allow for the examination of small group opinion and case studies. Case studies according to Flyvberg (Flyvberg, 2006) also offer the researcher a unique experience to gain expertise and diverse knowledge about a specific subject or subject area.

Since this research partly involves a review of stakeholder opinions, (which are prone to change), together with the fact that the process in itself has been one of trial and error, it can be termed heuristic. This means that part of this research has a basis in the personal perceptions of a group of individuals which may be biased in a particular direction, in this case, according to respondent belief or disbelief in the advantages of the Passivhaus standard/technology.

The research also exists within the context of Feminist and Constructivist philosophical perspectives which believe it is impossible to conduct research in an entirely 'value-free' or objective manner. This means that the researcher's values will have had some impact upon the research processes and interpretation of results as a matter of default. For this reason the research has been conducted in two main strands, the first is the review of the opinion of relevant respondents using Q-methodology and the second is the review of case studies which provide evidence from completed early Passivhaus developments in the UK and Germany. The two strands of research allow the respondent opinions to be compared or triangulated against the findings from the case studies, thus providing more balanced final conclusions.

The research also includes for a literature review chapter that focuses on innovation development theory and a chapter outlining a brief history of the development of super insulated buildings and the Passivhaus standard. The aim of these has been to provide a broader context within which the development of the Passivhaus standard in the UK can be understood.

Innovation

> *'Commit your blunders on a small scale and make your profits on a large scale'*
>
> (Baekeland, 1916)

The Development of Innovation

The aim of this chapter is to present some of the theories, processes, and themes that frequently surround the development of innovations. Thus providing a context within which to help describe and discuss the development of the Passivhaus standard as an innovation in the UK.

The evolution and development of any new technology or innovation sits within an existing context or the prevailing '*techno-economic paradigm'* (Guy and Shove, 2000) this consists of –

> *'The whole complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, regulatory requirements, institutions and infrastructures'*
>
> (Hoogma et al., 2002)

This is the case when looking at the emergence of the Passivhaus standard in the UK today.

The process by which an innovation or social change moves from inception through to production and full market or social acceptance is contingent on many external factors and does not necessarily follow a linear path. Its progression not only depends upon the quality of the innovation or idea but upon the social, technological and economic context into which it is presented or the incumbent culture.

According to Clyde Kluckhohn in his '*Mirror for Man'* (Kluckhohn, 1949) as cited in '*The Interpretation of Cultures*' by Clifford Geertz (Geertz, 1973), culture can be defined in a number of ways as follows –

- *' The total way of life of a people*
- *The social legacy the individual acquires from his group*
- *A way of thinking, feeling and believing*
- *An abstraction from behaviour*
- *A theory on the part of the anthropologist about the way in which a group of people in fact behave*
- *A storehouse of pooled learning*
- *A set of standardised orientations to recurrent problems*
- *Learned behaviour*
- *A mechanism for the normative regulation of behaviour*
- *A set of techniques for adjusting both to the external environment and other men*
- *A precipitate of history*

And turning perhaps in desperation, to similes, as a map, as a sieve, and as a matrix'
(Kluckhohn, 1949)

Culture is however often generally defined as acquired group specific behaviour that by nature of being acquired can change or be changed through internal or external stimulus. It is this broader definition of culture that is used in this thesis. As is the case with the theory for the biological processes of evolution that were first formulated by Charles Darwin and later studied in the work of the biologist Richard Dawkins, an innovation or idea develops within the context of a particular environment or culture but can only flourish if it continues to be supported by this environment or is able to successfully adapt to changes in that environment or culture.

In the same way as with the evolution of an organism, it is possible for an innovation or idea to thrive, become '*extinct*' or become completely forgotten or to mutate. An idea may also evolve in more than one place at a time, and the progression of that idea may move backwards as well as forwards.

In his book from 1976, '*The Selfish Gene'*, Richard Dawkins describes the process of replication of ideas within a cultural context by using the term *'Mimeme'* which he then abbreviates to '*meme*' to describe '*a unit of imitation'* (Dawkins, 1989). He believes that a meme behaves in a similar way to a gene in terms of replication. He describes a meme as follows -

> *'Examples of memes are tunes, ideas, catch-phrases, clothes fashions, ways of making pots or of building arches. Just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme pool by leaping from brain via a process which, in the broad sense, can be called imitation'* (Dawkins, 1989)

The process by which an idea is replicated or transmitted within a cultural context depends upon the idea taking root or gaining acceptance. This acceptance starts with the individual but moves to others and a wider cultural context through the development of supportive structures, such as technologies, social bodies and communication mechanisms or entire '*sociotechnical ensembles'* (Bijker, 1997).

In his book '*Of Bicycles, Bakerlites, and Bulbs: Towards a Theory of Sociotechnical Change*' Wiebe E. Bijker argues that the development of an innovation or technology is a '*social rather than a psychological process*' (Bijker, 1997) with the success of individual ingenuity only being supported by receptive systemic constructs. Taking this theory into consideration he believes that an innovator, designer or engineer must work with social, economic and political systems to achieve success -

> *'Another way of expressing this idea is to recognise that a successful engineer is not purely a technical wizard, but an economic, political and social one as well. A good technologist is typically a 'heterogeneous engineer.'* (Law, 1987)

Using examples of the bicycle and the 'daylight' fluorescent lamp, Bijker demonstrates that an innovation may evolve through the work of different inventors and over long periods of time. He also shows that it may develop across national and/or cultural boundaries. For example the first concept idea for a bicycle is often attributed to Leonardo da Vinci but its development into the bicycle version that we understand today has progressed from Germany to France and eventually to the United States and finally to England, where its evolution stabilised with a particular bicycle permutation rising to prominence – the '*Safety Bicycle'* (Bijker, 1997). At this stage it could be said that the development of this technology reached a state of '*Closure'* and *'Stabilisation'* (Bijker, 1997) or as Bijker describes it –

> *'Closure, in the analysis of technology, means that the interpretive flexibility of the artefact diminishes. Consensus among different relevant social groups about the dominant meaning of an artefact emerges and the 'pluralism of artefacts' decreases.'* (Bijker, 1997)

The history or the bicycle presented by Bijker also shows how, at times, the development of this innovation was obstructed because it was seen as a threat to existing livelihoods by some vets and blacksmiths who reacted by smashing early bicycles and working to prohibit its further development. Woodfoode describes this in the quotation below.

> *'Moreover, blacksmiths and veterinarians saw a direct economic threat in the vehicle. Blacksmiths are reported to have smashed hobbyhorses (early bicycles) that passed through their villages. This horse, they pointed out, required no shoeing'*
>
> (Woodfoode, 1970)

This type of scenario is also demonstrated in the story of the development of the 'daylight' fluorescent lamp. Here Bijker describes how the vested interests of those representing existing competing technologies worked to slow the progression of this technology in the market. For example after the introduction of daylight fluorescent lamps in the 1930s, many US utility companies became concerned that the high efficiency of these lamps would impact upon their businesses and their sales of electricity.

> *'The utilities started to fear that the high efficiency of the fluorescent lamp might reduce their electricity sales. As the utility executive Carl Bremicker of the Northern States Power Company said about his utility employees ''they had better get their white wing suits ready because very shortly General Electric and Westinghouse would have them out cleaning streets instead of selling lighting'' An internal Westinghouse memorandum lends support to the utilities' worries. It concluded that 'the average utility lighting man sees in the rise of fluorescence a decrease in his relative importance.'* (Bijker, 1997)

To combat this apparent threat to their businesses, various utility companies developed elaborate arguments and strategies to counter the claims of efficiency presented by the fluorescent lamp manufacturers. They argued that evidence did not exist to support the

lamp manufacturer's claims. They also attempted to discredit or mislead customers about the true nature and properties of the fluorescent lamp -

> *'Long and detailed arguments were given that the high-efficiency daylight fluorescent lamp really did not exist, but that it was mistaken for the fluorescent tint-lighting lamp, which indeed was a valuable new lighting tool, but only for limited purposes.'* (Bijker, 1997)

In the same way that the bicycle and daylight lamp reached final closure and stabilisation in one place, it can be argued that the development of the super insulated building is progressing towards closure and stabilisation with the Passivhaus standard in Germany. This is since the development of CEPHEUS (Cost Efficient Passive Houses as European Standards) programme at the beginning of the 2000's, which is further described in the brief history of Passivhaus outlined in the following chapter.

Innovation Diffusion and Communication

Not only is the successful development of an innovation linked to cultural context it is also intrinsically linked to the processes and communication methods by which it diffuses or is disseminated. In his much cited work '*The Diffusion of Innovations*' Everett M. Rogers uses case studies to demonstrate his theories surrounding the development and uptake of innovations. He sets out parameters which have now come to demonstrate how we generally understand the development or progression of innovations under typical or '*normal*' circumstances.

Rogers defines four key parameters in the innovation process as follows -

- **The Innovation**

This is the -

> *'idea, practice or object that is perceived as new to the individual or other unit of adoption'* (Rogers, 2003)

It can be a technology or take the form of information or an ideology, or in the case of Passivhaus, a building design standard. Rogers stresses that an innovation is not just one

idea or object but a combination of innovations which surround a core innovation, and it is the definition of the boundaries around this core and the other closely interrelated innovations and technologies which form a '*technology cluster*' (Rogers, 2003). A technology cluster is defined as the component parts that make up the innovation as a whole. For example in the case of the bicycle cited by Bijker, this cluster would include innovations of pneumatic tyres, gears, brakes etc., but also social acceptance of bicycle riding, all of which would have to be combined to form a supply chain system surrounding and making up the core innovation.

In the case of the Passivhaus standard this technology cluster would include components such as the design software PHPP (the Passivhaus Planning Package), high performance windows, high efficiency MVHR (Mechanical Ventilation with Heat Recovery) units, other relevant building construction components (such as tapes and membranes), but also the people with the appropriate skills to design and construct Passivhaus buildings and those who want to live and work in Passivhaus buildings.

Rogers cites the '*Characteristics*' (Rogers, 2003) of an innovation that make it compatible with social values as of key importance. These characteristics should ideally offer a relative advantage to adopters if the innovation is to become successful and thrive. In the case of the development of the Passivhaus standard in the UK, its potential for acceptance within existing and 'normal' social frameworks, together with the perceived advantages for adopters are both relevant considerations when considering its potential evolution.

The overall '*complexity'* of the innovation is also considered important by Rogers as is its *'trialability'* and '*observability*' so that it can be judged compatible with specific markets and tested for performance in relation to particular circumstances. Taking these factors into consideration, if the Passivhaus standard is to successfully develop in the UK it needs to be proven viable to build, suitable for occupants to live in and desirable for customers.

- **Communication Channels**

The connective communication networks or channels that surround an innovation are considered by Rogers as key elements to its success. These are defined by Rogers as being –

> '*the process by which participants create and share information with each other in order to reach a mutual understanding'* (Rogers, 2003)

They are the methods by which a message or messages are delivered from one individual or group to another. These channels include individual communication mechanisms such as word of mouth but also for social networking modes of communication and mass media channels such as TV, radio, journals and newspapers etc.

Rogers indicates that previous diffusion research has shown that most individuals do not judge a new innovation based primarily on its scientific merits but on subjective views which are communicated most strongly through members of their social peer group, with these social peers usually being homophilious or very similar people. For example, to date, the German Passivhaus standard has developed most widely in Germany, Austria and Switzerland which share the German language and many similar cultural attributes, thus helping to support the theory that dissemination may progress more easily across more homophilious cultures, or those with similar values. It is however argued that it is not just cultural values that are important when understanding the dissemination of an innovation but the psyche of individuals forming component parts of a group or community, with those who are most innovative being most able and willing to adopt innovations at the early stages of development. According to Geoffrey A. Moore, as described in his book '*Crossing the Chasm'* (Moore, 2007) progression of an innovation beyond the most innovative members of a community requires a market strategy, and the definition of boundaries for dissemination or it may not succeed. This is achieved by isolating and focusing on a specific target market or segment to achieve success, with an understanding that different market segments or sectors have different characteristics.

- **Time**

In the same way that Moore argues that the success of innovation dissemination requires the definition of a specific market sector and the targeting of this sector, Rogers argues that time boundaries for the dissemination of an innovation must also be defined. Rogers believes that time is a key consideration when understanding the dissemination of an innovation, since without an understanding of time-frame boundaries surrounding the intention to communicate or promote an idea for adoption then a diffusion process can theoretically be endless.

In the case of the evolution of the Passivhaus standard, it can be argued that the development of the CEPHEUS programme which operated within specific structured boundaries and a time-frame contributed to the final development of the Passivhaus standard by providing set parameters and a deadline or endpoint for its development.

A good understanding of time-frame can also provide a perspective when assessing the length of time it takes for individuals to realistically encounter or first hear about an idea through to them actually adopting it, this would be of particular relevance to those seeking to manage an innovation process.

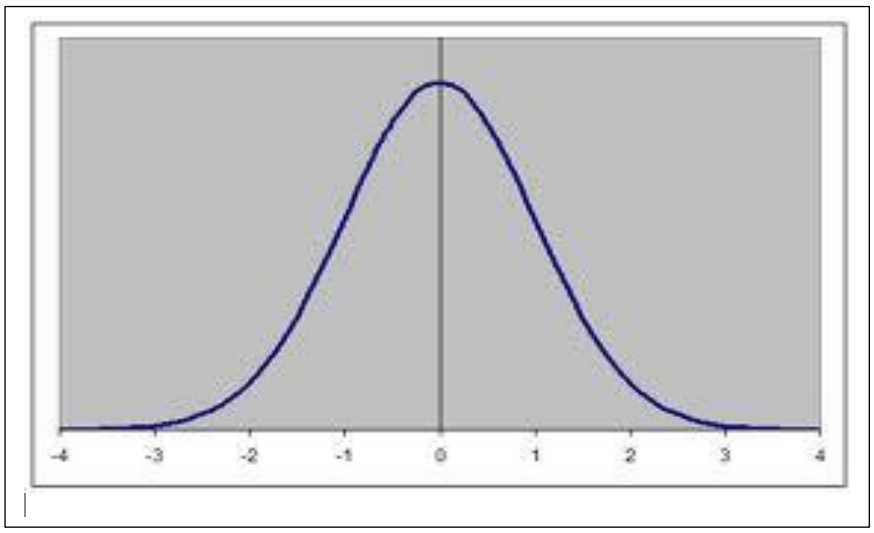
Rogers characterises the different '*time*' phases that an individual takes to adopt an innovation into five separate stages –

> '*knowledge*', '*persuasion*', '*decision*', '*implementation*', and '*confirmation*'. (Rogers, 2003)

Where '*knowledge'* is the stage when an individual first learns about an innovation, '*persuasion*' being when an individual forms a favourable or unfavourable opinion about it, decision being when the individual either decides to adopt it or not to adopt it, '*implementation*' being when an individual puts the innovation to use and '*confirmation*' being when an individual seeks final support or reinforcement from their peer group as to whether to finally support and adopt that innovation.

The time component relating to the adoption of an innovation can vary according to the type of innovation. Often adoption rate can be described using a Gaussian curve of 'normal' distribution with the rate of adoption shown rising and diminishing over time.

Figure 1 - The Gaussian Curve - Normal Distribution



The steepness of this Gaussian curve can however vary dramatically if an innovation is perceived as being more advantageous to adopters or if it is supported by specific socio-political constructs such as mandatory regulations.

Since 2007 the Passivhaus standard has been adopted as a building standard in Frankfurt for specific developments –

> *'Erst aufgrund unseres Erfolges hat die Stadt Frankfurt beschlossen, dass 1, städtishe Grundstücke mit der Auflage verkauft werden, dass der investor dort Passivhäuser errichten muss, und 2, dass bei Bauvorhaben der Stadt Frankfurt wie Kindergärten, Schulen, Bürogebäuden etc., diese in Passivhaustechnologie zu realisieren sind*'. (Laible, 2010a)

My translation into English is as follows -

> *'First because of our success the city of Frankfurt has decided that 1, that investors must build to the Passivhaus standard on public land that is sold off 2, that the city of Frankfurt must build kindergartens, schools and office buildings using the Passivhaus technology.'*

This has led to a dramatic rise in the number of new Passivhaus buildings constructed in Frankfurt since the first project of 19 flats was completed there in 2003 with the St.Jakob's development in Grempstraβe. This is used as a case study in this thesis.

Franz Junker who is the Director of ABG Frankfurt Holding GmbH estimated in an interview with Passivhaus Kompendium magazine in 2010 that there is a minimum of 100, 000 m^2 of Passivhaus dwellings in Frankfurt and that there are plans to build between 500-600 flats per year over the next few years.

> *'Wir haben ein groβes Investitionsvolumen vor uns und bauen in den nächsten Jahren järhlich rund 500-600 Wohnungen und diese natürlich alle in Passivhaustechnologie'* (Laible, 2010a)

My translation of this into English is as follows -

> *'We have a large volume of investment in front of us and in the coming years will annually build around 500-600 flats, naturally all of these using Passivhaus technology'.*

It can however be argued that a policy decision alone is not enough to stimulate an innovation's success, with the overall socio-political context also being of vital importance.

When considering the cultural infrastructure that surrounds the development of an innovation Speirs et al argue in their paper '*Adapting Innovation Systems Indicators to assess Eco-Innovation*' (Speirs et al., 2008a), that there are three key factors which form the main component parts of a successful innovation structure, all of which must function coherently for the system to work. These components are; '*the Firm'* (or organisation developing the innovation and including the innovation), '*the Conditions*' (which are the context surrounding the development of an innovation) and '*the Linkages'* or communication framework within which it exists. These components must in turn sit within a specific socio-political environment that includes –

> *'The basic educational system, this being responsible for the general level of education throughout the workforce;*
>
> *The communication infrastructure, roads, audio and data communications;*

Financial institutions, determining the access to finances including venture capital;

Legislative and macro-economic settings, including patent law, taxation, corporate governance rules and trade policy;

Market accessibility, including possibilities for the establishment of close relations with customers, market size and ease of access and;

Industry structure and the competitive environment, including the existence of supplier firms in complementary industry sectors'(Speirs et al., 2008a)

Speirs et al consider that all the above list of elements, which form a culture, are vitally important for the success of an innovation and to support innovation in general. If an innovation cannot function within the above systems or is not supported by them it will potentially be suppressed and may fail. It is also relevant to note that Speirs et al see these elements working together as part of a non-linear system of integrated parts, or an holistic whole with each element also acting as a separate micro-cosmic system working to support the entire cultural matrix.

When considering the first element in the framework described by Speirs et al, the research work of Linda Clarke and Georg Herrmann describes the different nature of construction industry skills cultures in the UK and Germany. This is presented in their paper '*Divergent Divisions of Construction Labour – Britain and Germany '* (Clarke and Herrmann, 2007). They conclude that there are substantial institutional, structural and skills levels differences between the UK and Germany, with Germany having better integrated systems and generally higher levels of construction skills than in the UK.

'One important explanation is the institutional framework governing construction of skills in Britain, is so extremely different from that found in Germany' (Clarke and Herrmann, 2004)

It is possible that the comparatively better integrated and more highly skilled construction industry in Germany has recently better supported the development of the Passivhaus standard in that country rather than in the UK. This is because Passivhaus designs are considered to require a greater attention to design and construction detail than is usually

associated with the delivery of standard buildings in the UK. There are currently tens of thousands of Passivhaus buildings in Germany as opposed to only about twenty-four accredited examples in the UK as of the beginning of 2012 (Passivhausprojekte, 2012).

The results of testing from the first pilot Passivhaus project at Kranichstein and the testing of the CEPHEUS project show that achieving the Passivhaus standard is reliant on the availability of high performance components, co-ordinated design and construction skills and good levels of quality assurance (Feist, 2006).

According to '*Passive House Solutions'* (IEE, 2006) a report produced by Intelligent Energy Europe, dated May 2006, the major barriers to the uptake of the Passivhaus standard in the UK are seen to be the current build quality of housing and the competence of UK labour, which may work to prevent the high level of construction detailing required for Passivhaus air-tightness performance being delivered. The absence of a similar construction industry culture to that in Germany, as described by Clarke and Herrmann, may work to act as a barrier to the wider development of the Passivhaus standard in the UK.

In his presentation titled '*Passivhaus in the UK: Challenges of the Emerging Market*'(Hodgson, 2008) which was presented at the 12th Annual Passivhaus conference in Nuremberg, Germany in April 2008, Gavin Hodgson who formerly represented the Passivhaus Standard in the UK at BRE (Building Research Establishment), outlined several barriers that he considered were affecting the uptake of the Passivhaus Standard in the UK, these included the following –

- A lack of understanding of the Passivhaus Standard in the UK
- Reluctance to accept 'unproven' concepts
- General unavailability of components and secure supply chains together with an immature market for components
- A lack of financial incentives
- Cost
- Lack of skills in both design and construction
- UK working methods
- UK procurement systems

- Lack of cohesion of legislation and regulation
- Perception
- Little understanding of a foreign (German) language product
- Climate specifics

In the report '*A Low Carbon Building Standards Strategy for Scotland – Report of a Panel Appointed by Scottish Ministers, chaired by Lynne Sullivan 2007*' (SBSA, 2007) a select panel reviewed the potential for the Passivhaus Standard to be incorporated as part of the solution to meet 'zero carbon' building targets in Scotland and to –

> *''... progressively deliver carbon dioxide emission savings from buildings, with an ultimate aspiration of 'total life' zero carbon buildings by 2030'* (SBSA, 2007)

Key recommendations from this report were that buildings in Scotland should be designed to be '*net zero carbon'* (SBSA, 2007) by 2016/2017 and that the Passivhaus standard should be examined in terms of occupancy behaviour and comfort as a solution to meeting these aspirations. This was combined with the recommendation that there should be an examination of the implication for the use of specific technologies required to achieve -

> *'...net zero carbon buildings (i.e. space, water heating, lighting and ventilation) by 2016/2017 if practical'*

and –

> *'...consideration of 'Passivhaus' performance and its effect on occupant behaviour and comfort'*

and an –

> *'... examination of the building regulations and associated guidance with respect to low carbon equipment, including consideration of the design of buildings for future installation of certain technologies'* (SBSA, 2007).

One specific finding of this report that relates to the potential that Passivhaus has to meet the UK's 'zero carbon' building design standards is the opinion of Rainer Mikultis from the Austrian Institute of Construction and Engineering, who advised the panel that –

> '*you could not impose 'Passivhaus' living habits on home owners and occupiers'*

due to the fact that -

> *'to realise the enhanced energy performance and to avoid mould growth from condensation, the occupants must be prepared to adjust their life style to rely solely on mechanical ventilation with heat recovery (MVHR) including frequent changes of filters and the associated running costs'* (SBSA, 2007).

No expanded reasons for the above were given in the report, but it can be assumed that an 'adjusted lifestyle' would require adherence to the fact that MVHR units need to be kept running during the heating season to maintain comfort, indoor air-quality and humidity levels if windows are not opened, but also that MVHR units require maintenance and filters to be changed at regular intervals to maintain good indoor air-quality.

When reviewing the broader picture and comparing UK and German sustainable housing, in his paper '*Low Energy and Sustainable Housing in the UK and Germany*' (Morbitzer, 2008), Christoph Morbitzer argues that the cultural focus on attention to detail have been of vital importance in the development of the Passivhaus standard in Germany.

> *'Still, this 'attention to detail' observed in the German building sector was also a key requirement for the development of the Passivhaus. The technical skills and the ability to deliver high quality construction components are also vital for the successful application of the design concept.'* (Morbitzer, 2008)

Morbitzer however then goes on to argue that he believes it is the UK culture of holistic thinking which has led to the development and wide dissemination of building design

standards such as BREEAM (Building Research Establishment Environmental Assessment Method) that has been a cultural strength in the UK over the past decades.

> *'The Passivhaus applies a design approach where form, fabric and services systems are all designed to work in harmony and support each other towards the goal of achieving a design with low energy consumption. But actually such 'holistic' thinking has over the last two or three decades been a strength of the UK, rather than Germany.'* (Morbitzer, 2008)

Case studies in the following chapters show examples of early UK Passivhaus developments which have employed the UK design codes BREEAM and the CSH standards alongside that of the Passivhaus standard. Thus potentially indicating areas where the two different cultures described by Morbitzer could work together to advantage.

A Social System of Diffusion

Just as Speirs et al propose that successful innovations develop through the support of and as part of integrated evolutionary systems, Everett M. Rogers argues that innovation development is reliant on functional social systems for diffusion.

Rogers defines the '*social system'* as

> *'a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal'* (Rogers, 2003).

These units could be various different groups linked by social structures and would include specific individuals such as leaders and '*change agents'* who act to promote or communicate ideas within this context. The structures linking the groups within the system may vary in complexity and effectiveness according to context, but in all systems the roles of the leaders or '*change agents'* are important catalysts for dissemination. Typically change agents are people who are more innovative, better educated and have more channels of communication available to them than the rest of a community.

The actual process of dissemination of an innovation is also linked to the categories of people who may adopt it at various stages of its development. In his '*Adopter*

Categorisation' curve, Rogers shows us the different categories of people who may typically adopt at different phases of its evolution.

The graph below presents a curve which is divided into five sections representing adopter groups in relation to their innovativeness –

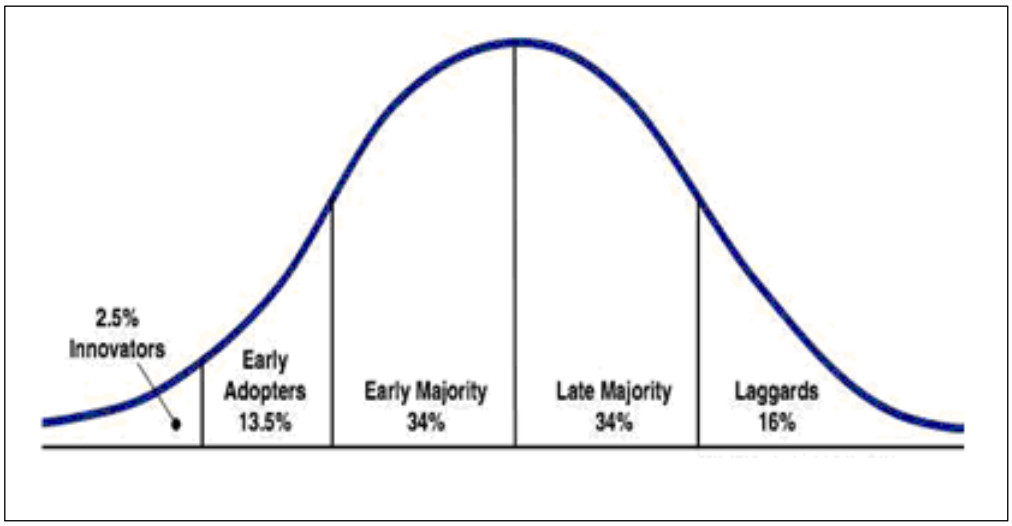


Figure 2 - The Different Phases of Adoption

'*Innovators*' who occupy 2.5% of the individuals are shown to adopt an innovation at its earliest phase of development, followed by '*Early Adopters'* who represent a further 13.5% of the individuals, the '*Early Majority* 'representing the next 34%, the '*Late majority*' representing a further 34% followed by the '*Laggards*' who represent the remaining 16% of a populace.

The names used to describe the particular groups are probably self-explanatory since they distinguish the different groups according to their degree of innovativeness, with the '*Innovators*' and '*Early Adopters'* being the most innovative, but taking up a smaller percentage of those involved in the entire process than the majority, but the same percentage as the '*Laggards*' at the tail end of the process.

When considering the definitions of these adopter groups, research undertaken by Rogers and shown in his case studies tells us that these categories also relate to specific social groups with varying degrees of education, cosmopolitan outlook and social status. For

example, those with higher degrees of education, socio-economic status, exposure to mass channels of communication, interpersonal communication channels, and with higher degrees of social participation, who know more change agents and are more cosmopolite, tend to be early adopters of innovations, they are not however necessarily the Innovators.

The significance of gaining an understanding of the social groups or target audience for a new idea or innovation is considered by Rogers as important when trying to manage or stage the development of an innovation, since it provides anticipated information as to the likely behaviour of each group in terms of speed of adoption or readiness to adopt or not. For example the number of completed accredited Passivhaus buildings in the UK is currently in the 'tens' rather than the 'hundreds' or 'thousands' as it is in some other European countries. As a proportion of the new-built housing stock this would be equivalent to a fraction of a percent. Thus the adoption of the Passsivhaus standard in the UK currently sits early on within the 'Innovator' stage of adoption.

Understanding the specific social groups who are targeted by a new innovation and the social groups forming the social system into which a new innovation is to be launched is linked to its development through identification of the needs of these relevant groups. Usually if an innovation is to be successfully adopted it has to meet the needs of the target community or a specific need within the community has to be stimulated. This can be achieved through gaining an insight into and understanding existing needs then developing mechanisms to support them.

This process can be initially instigated through the identification of leaders or change agents within groups and marketing the ideas or innovations directly to them. When these agents adopt the new innovations they can act as role models for the next level in the innovation chain, 'the early adopters', thus the process can progress until critical mass is reached and the innovation is adopted by the mainstream of a community.

However, according to Geoffrey A. Moore, in '*Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers*'(Moore, 2007) if an innovation process is to be successful it is contingent upon the understanding of its communication beyond the innovator and early adopter phases to the majority or mainstream, since it is at this stage where there is the greatest cultural boundary or chasm between the groups and where

there is most risk of failure. Moore describes some of the difference between early adopters and the mainstream as follows -

> *'The single most important difference between early markets and mainstream markets is that the former are willing to take responsibility for piecing together the whole product (in return for getting a jump on their competition) whereas the later are not'*(Moore, 2007)

Moore therefore argues that if an innovation is to move beyond the early adopter phase it must be developed in a way that can also support the customer/user.

Co-Evolution

Sometimes innovations are successful from only one standpoint, for example they may be effective in the generation of profit for the developers of the innovation but they are not strictly relevant to user or customer needs, as in the case of some fashion items. In his book '*Synchronising Science and Technology with Human Behaviour*' (Brand, 2005) Ralf Brand argues that these types of innovations have often been the product of development processes that value the technological rather than the social aspect of an innovation.

When considering technology as the main driver or innovation, the term '*Technological Determinism'* is used to describe the belief that the development of a new innovation or technology is enough to trigger society to change in itself and that the technology exists outside the context of society (Brand, 2005). According to Brand, this belief has often been attached to the development of technologies and innovations that serve the main purpose of providing profit for the manufacturers as the key driving motive for production, rather than provision of maximum holistic benefit for consumers inclusive of social benefits.

Some consider that a more enlightened view when promoting the development of new innovations is to try and incorporate the needs of the consumers from the earliest stages of research and development, or to take a '*co-evolutionary'* approach.

In '*Synchronising Science and Technology with Human Behaviour*' Brand argues in favour of the process of co-evolution when developing and disseminating new innovations and ideas.

He uses two key case studies to demonstrate his thinking. The first case study looks at the successful attempts of the Belgian town of Hasselt to implement a green transport strategy to accommodate increased public transport use. The second case study examines the promotion of local produce and shopping in the German town of Fürstenfeldbruck.

For both of these case study examples, Brand shows how new local government policies and infrastructure are successfully integrated into existing systems via the use of co-evolutionary strategies that work to engage the public as part of the processes. The processes used were shown to enable the inhabitants of Hasselt and Fürstenfeldbruck to gain social 'buy-in' into the strategies and this supported the implementation of new technologies and processes. These new policies were implemented concurrently as government interventions or from a '*top-down'* approach combined with a '*bottom-up'* or community led perspective. This co-evolutionary method of policy implementation correlates with the findings of Rogers in his case studies which show that the successful diffusion of innovations requires social intervention and community 'buy-in' to support technological development.

In the case of the Belgian town of Hasselt the goals of the new transport policy were to reduce traffic volume entering the centre of the town and to increase the use of public transport. These goals were achieved through a cluster of innovations including larger scale planning of technological infrastructure interventions such as the narrowing of car lanes, the introduction of traffic lights and new signals guiding cars away from vulnerable city centre areas, combined with the provision of bicycle paths and infrastructure and new car-free quality amenity space in and around the town centre. The large scale physical interventions were supported by smaller more immediate social interventions such as the promotion of car-free days and 'shopping by bus' schemes. Most significantly the promotion of the use of public transport was achieved via improving the image of the buses and the provision of free public transport which acted as a significant carrot to incentivise its use. Hasselt has now gained international notoriety because of its '*free*' transport policy.

> *'Hasselt's public transport policy has gained international attention because it is currently the only city in the world providing public transportation completely free of charge'* (Brand, 2005)

The new transport strategies for Hasselt were supported by public engagement exercises which incentivised behaviour changes such as promoting cycling to work or school instead of driving. This was achieved by offering prizes to schools or work places that recorded the highest number or pupils or staff travelling by bicycle on specific days. To support this, penalties were implemented to discourage car use with higher parking costs introduced for the town centre.

The new transport strategies for Hasselt have shown long term cost savings in reduction of maintenance costs for parking or the need to provide additional new roads to cope with car use. They were however only viable due to state subsidies. While many in the town have been happy with the transport strateby results and the free buses, some residents have complained that they should not be paying for buses if they do not themselves use them.

In the case of Fürstenfeldbruck strategies were introduced to try and increase spending on local produce. The aim of this was to support local farmers and businesses that were being financially squeezed through the policies of large supermarkets and industries that brought goods into the area from outside. Thus not directly supporting the local economy, and resulting in social and environmental deterioration in the local area.

This strategic intervention was instigated through the development of a community organisation called Bruckerland which worked to promote local farmers and businesses. This was created through engagement with farmers with the offer to buy and sell their local organic produce at a higher price than was being paid to them by the supermarkets. Their products were then sold as prestige products in the local area. In conjunction to this Bruckerland engaged with the supermarkets to encourage them to stock more local produce supplied by Bruckerland with this produce being clearly labelled to identify it as special. In this instance the additional cost for the Bruckerland produce was passed on to the customers who paid between 12-35 % more for items but with prices still being cheaper than conventional organically produced products.

Overall the Bruckerland project was shown to be successful in promoting and supporting local farmers and businesses but was not found to generate excessive economic benefits for them. What it managed to do was to raise the profile of local businesses and to encourage

residents of the local area and key organisations, e.g. hospitals, to support and buy local produce on a regular basis.

> *'BruckerLand was able to attract some quantity buyers like the county hospital and ten restaurants that serve seasonally adapted meals'* (Brand, 2005)

The cases of Hasselt and Fürstenfeldbruck demonstrate the importance of social intervention in achieving the successful introduction of new innovations. These examples also show the need to use methods that incentivise positive behaviour change at the same time as those which discourage existing negative behaviour, or using both '*carrot and stick*' policy approaches combined. While these two examples have however been shown to be relatively successful, there have been many situations where the introduction of new innovations has created strong resistance because the needs or perceptions of the target audience have either, not been properly assessed, understood or engaged with. This is often the case if the change or innovation that is to be introduced is perceived as being too radical. Brand reflects upon one incident when the German 'Red-Green' government of 2002 tried to introduce rises to fuel taxes.

> *'Because every democratically elected government knows that if it steers the cart into too sharp a curve, it is likely to lose support on election day. This is what happened to the German Red-Green government in 2002 after it implemented the first step of an ecological tax reform that increased the price of gasoline by approximately 3 per cent.'* (Brand,2005).

The point above demonstrates the complexity and fragility of dealing with diverse markets when trying to introduce new innovations, but also the importance of gaining consent or social 'buy-in' from all those who will be affected by the changes. This theoretically can be achieved through specific communicative strategies which seek to engage with and understand the needs of communities at the same time as providing explanations as to the relevance and benefits of the proposed interventions. This type of community intervention strategy was employed with the development of the first Passivhaus flats in Grempstraβe in Frankfurt where residents were engaged in the design process from the earliest stages of development. This was also the case with the development of the KlimaSolarHaus

Passivhaus development in Berlin. These developments are described in the case studies chapter from this thesis.

Social Complexity

The degree of social complexity and cultural diversity surrounding an innovation can have strong impacts upon its success. In his book '*Why we Disagree about Climate Change: Understanding Controversy, Inaction and Opportunity'* (Hulme, 2009) Mike Hulme discusses the complex nature of gaining consensus from the diverse range of communities, (each of whom hold differing beliefs), that make up our society. Hulme's discussion relates specifically to the issue of Climate Change but it is also relevant when considering the processes of adoption or promotion of any new idea or innovation.

Through presentation of findings from a questionnaire conducted on the theme of the risk of Climate Change with 700 Americans in 2003 by psychologist Tony Leiserowitz, Hulme shows how the different beliefs and values of specific cultures within a society are reflected in the opinions and reactions of their individual members. He demonstrates that cultural identities are stronger than commitments or affiliations to political parties. He also argues that those with more egalitarian beliefs had a stronger perception of the risks associated with climate change than those he describes as *'individualists'* and '*hierarchists*'(Hulme, 2009). This finding is supported by the work of Douglas and Wildavsky from 1982 in their essay '*Risk and Culture: an essay on the selection of technological and environmental dangers'*(Douglas and Wildavsky, 1982). They demonstrate how risk is not assessed on the basis of '*objective*' technical analysis but through the particular social, cultural and ethical contexts that an individual inhabits (Hulme, 2009). Thus it is argued that '*risk perceptions are socially constructed*' (Hulme, 2009) and that

> '*messages about climate change need to be tailored to the needs and predispositions of particular audiences if they are to resonate with strongly held values*' (Hulme, 2009)

If this premise is related back to the development of the Passivhaus standard in the UK, it could be argued that for successful broad adoption, appeal would have to be tailored to the predispositions of the relevant market groups of potential adopters.

One of the earliest accredited Passivhaus homes to be completed in the UK is the Denby Dale Passivhaus which employs the traditional UK cavity wall construction method. This construction technique was primarily employed for planning reasons but also to show people in the UK that the Passivhaus standard could be achieved when constructing homes in a traditional UK vernacular style. This development is described as one of the case studies in the Case Study chapter of this thesis.

The Individual Innovator and the Innovation System

The work of historian Arnold J. Toynbee discusses how he believes that growth or innovation is driven by '*creative minorities'* who find solutions which others then follow, through the process of *'mimesis'.* Thus the role of the '*creative individual'* is very similar to that of the '*Innovator***'** as described by Rogers. In his work Toynbee also argues that innovation is key to the progress and development of society and cultures and that failure to support '*creative minorities'* (Toynbee, 1960) and innovation may lead to cultural and social demise**.**

The Innovator is often characterised as being somebody who stands outside of the broader social realm, and who is better educated and more creative than the 'norm'. However the innovator and the development of innovations need the support of the whole system in order to survive and thrive.

In the paper '*Translating Sustainabilities between Green Niches and Socio-Technical Regimes'* Adrian Smith develops an argument that there is insufficient understanding of how knowledge from '*green niches and regimes*' (Smith, 2007) can be translated to the wider market. He also stresses the importance of these 'niches' in the generation of innovation/s that would be potentially widely beneficial to society as a whole.

Smith demonstrates his argument by discussing the case of development of the '*Energy World Project in Milton Keynes*' where, in the 1980's 50 low energy houses were built to several different low energy designs, but also the case of various programmes that were undertaken to test and develop renewable energy technologies at CAT (the Centre for Alternative Technology) in Machynlleth in the 1990s. He explains that while these projects

managed to impact upon methodologies for the testing of further projects in the UK, they did not manage to have a large impact on mainstream building design and construction practices in the years immediately subsequent to the testing. Smith explains this as follows -

> *'A more ambitious project was the Energy World at Milton Keynes in the mid 1980's. It consisted of around 50 low energy houses built to different designs and testing various technologies. While this helped in the development of monitoring and standards protocols, it did not make a big impact on mainstream building. Falling energy prices reduced tensions within the regime and mainstream interest waned. In nearly all the cases, formal learning influence was narrowly technical and disseminated through specialist reports. Niche influence was limited to an occasional source of 'good practice' guides and technical reports. Renewed interest has emerged recently. A number of government task forces and programmes have been launched to promote sustainable housing. These run the risk that limitations under previous niche engagement will be repeated.'* (Smith, 2007)

This observation starts to suggest that this test development of low energy housing in the UK has not been very successful in terms of providing a basis to support the mainstream house building, and the wider construction and consulting industries, towards the development of low energy homes. Understanding why this has been the case asks questions of the innovation processes and systems that were employed in this instance.

In the paper *'UK innovation systems for new and renewable energy technologies: drivers, barriers and systems failures*' (Foxon et al., 2005a) Tim Foxon et al argue that an innovation is a non-linear process which involves feedback at different stages of development and is defined as –

> *'The elements and relationships which interact in the production diffusion and use of new, and economically useful, Knowledge'* (Lundvalle, 1992)*. Thus, rather than being categorised as a one-way, linear flow from R+D to new products, innovation is seen as a process of matching technical possibilities to market opportunities, involving multiple interactions and types of learning'* (Freeman and Soete, 1997)*.*

Thus innovation can be seen as a process or a system.

If for example elements of the innovation system are dysfunctional or not working to their optimum, then the development of an innovation can stop or slow. Foxon et al present the case that this has been the situation with the development of systems surrounding the introduction of renewable energy technologies in the UK in recent years, with weak policy framework and measures cited as contributing to the disruption of the system. Foxon et al argue for a more stable and consistent policy framework to support the early stages of innovation and R+D before it reaches the market, thus off-setting much of the risk associated with this stage of the innovation process.

Smith's conclusions have similarities to the findings of Foxon et al when he focuses on weak regulation as failing to act as a satisfactory component in the chain of innovation. He presents a case that regulation did not allow embryonic and test ideas to flourish and progress to the mainstream. Thus innovator and early adopters were not properly supported to the loss of the wider social context. Smith explains this further below -

> *'In the absence of widespread consumer concern for greener housing, regulation is the key environmental driver in volume house-building. Regulation has been slow to articulate a clear and strong signal for sustainable housing. Standards for insulation have improved periodically (whenever tensions warranted). Standards are currently being extended to a wider set of sustainable considerations (e.g. water use). However, this regulation-driven translation is relatively undemanding because it does not encourage deeper learning and second-order translation. Standards and codes are piecemeal rather than holistic, and are negotiated on the basis of what is judged to be a reasonable demand, given mainstream socio-technical practices.'*
> (Smith,2007).

Innovation, Culture and Feedback

The most successful innovation systems include feedback mechanisms that aim to understand what has functioned well and what has failed. These allow for refinement of an innovation. Feedback can take different formats from the monitoring of technical performance of physical products to the monitoring of social acceptance and desirability. Feedback can also track the development process of the innovation and the mechanisms by which it has been implemented or brought to the '*market*'.

The type of human interaction with an idea or innovation can be a key reason why it is a success or fails. Sometimes innovations that could be useful for a target audience fail because they are not understood by the audience for whom they are intended or they are not understood as appropriate within the cultural context within which they are promoted. This type of '*cultural block*' is described by Jared Diamond in his book '*Collapse'* (Diamond, 2005) which cites the example of the US state of Montana that hosts large forested areas and is prone to forest fires, which frequently cause severe environmental and financial damage and destruction to community and individual property. Montana foresters have been aware that specific forest management regimes would significantly reduce the potential incidence and impact of these fires but only at an additional cost to the state.

Diamond explains that because the prevalent culture in the state of Montana is suspicious of government and government intervention, there is no wide scale support for state funded solutions and innovations which could help to prevent the forest fires and the associated negative impacts. Instead larger scale sporadic costs are incurred by communities and individuals to compensate for damage caused by the fires.

Sometimes people will resist a new innovation because it challenges or threatens their livelihood or the status quo, or because they feel threatened by the means by which it is communicated. They may also not understand the purpose of the innovation or how it works, or any alteration to behaviour that would be required to adopt it. Innovations are by nature new and require behaviour change for their adoption. The degree to which respondents or customers must adapt to adopt an innovation depends upon the nature and

complexity of the innovation. Sometimes the introduction of an innovation requires specific respondent/customer training or instruction for its success at other times behaviour change can be more intuitive.

According to the findings from the case studies chapter of this research documenting interviews with residents of the St.Jakob's flats in Frankfurt and the KlimaSolarHaus in Berlin, some degree of behaviour change has been required by residents in order for them to live in a Passivhaus in comparison with living in a 'conventional' dwelling, especially so that residents can achieve optimum thermal comfort. The need for behaviour change was also noted by the residents of the Denby Dale Passivhaus who commented that it would be a good idea to provide some kind of instructions as to how to live in a Passivhaus for future Passivhaus residents (Butcher, 2009a). In response to a need to provide living instructions for Passivhaus residents, the Passivhaus Institute in Darmstadt has produced some instructions in the form of '*Nutzer*' or '*User*' handbooks (Pfluger and Feist, 2008).

Arguably resistance to the adoption of innovations is largely encountered with innovations that are implemented without a co-evolutionary framework such as with the technical deterministic approach. A criticism of a technological deterministic approach to the implementation of innovations is that only this top-down perspective does not allow for proper social engagement with the consumer. This criticism can also be levied at an architectural deterministic approach to building design. '*Architectural Determinism'* is the term for architectural interventions that are typified by a top-down approach to design and which aim to modify human behaviour only through physical design. An architecturally deterministic design is frequently perceived as being restrictive for occupants and one that does not employ the consumer or occupant as part of the design or operation process. An extreme example of this would be Jeremy Bentham's Panopticon, which was a circular prison with cells built in a curve facing inwards, allowing prison inmates to be easily observed from a central control point (Brand, 2005).

Brand argues that those finding themselves in situations where they feel unable to control their environment such as being an inmate in a Panopticon prison, may react negatively against it and -

> *'In many, if not most cases, the patronised human objects will find ways to regain their subjecthood by means of some creative or sullen form of subversion, disobedience, modification, sabotage, counterstatements* (Pfaffenberger, 1992)*antiprogrammes* (Latour, 1992)*on the election ballot*' (Brand, 2005)

This may not just be relevant when considering the development of buildings but applies to the introduction or development of any new innovation, inclusive of building standards such as the Passivhaus or other standards which may call for the implementation of specific technologies such as MVHR.

As with other types of innovation, it is arguable that the construction and habitation of a new building would likely require some form of instruction or training so that occupants are enabled to use it. For example some degree of understanding about how to operate building services systems or how to carry out maintenance regimes would ideally be provided.

This is the argument made with the introduction of the UK '*Soft Landings*' (BSRIA and UBT, 2009) programme which aims to promote better understanding of the processes governing the design, construction and habitation of buildings. The sentiments of the Soft Landings programme support the findings of Brand and Rogers and their belief in the benefits of a co-evolutional approach to development. This is supported by Hill et al in their paper '*Consumer impacts on dividends from solar water heating*' (Hill et al., 2011). Hill et al argue that recent installations of solar thermal water heating in the UK have been marred by poor installation and lack of user awareness as to how to operate systems due to lack of instructions for tradespersons installing the technologies and consumers using them.

Triggering Innovation

Innovation is arguably a key contributing factor for the development and growth of a society and social systems. Foxon et al maintain in their paper '*UK Innovations Systems for new and renewable energy technologies: drivers, barriers and systems failures*' (Foxon et al., 2005a) that innovation is also important for economic prosperity –

'Innovation is a principle source of economic growth' (Mokyr, 2002)

' and a key source of new employment opportunities and skills, as well as providing potential for realising environmental benefits' (Foxon et al., 2005a).

This paper promotes the idea that a good understanding of the processes that enable or work to support innovation are useful in the context of the development of an economy and especially the development of new '*green*' economies. Through researching different innovation systems using a standard framework approach, Foxon et al also conclude that for innovation to be successful then '*different actors with distinctive roles'* (Foxon et al., 2005a) need to work together

'*developing a shared vision between government, industry and the research community*' (Foxon et al., 2005a)

Foxon et al also stress that early stage development needs to be supported through fostering 'niche' developments with an understanding that at the early stages in the evolution of an innovation, it will require financial support together and the understanding that not all new ideas will prove successful.

Key points that this paper stresses are that a current lack of core skills combined with a deficit in joined up thinking within UK policy has recently blighted the development of renewable energy technologies in the UK. It is possible that since the Passivhaus standard could also currently be defined as a niche 'green' technology, this technology might also be subject to similar problems in the UK.

In his paper '*Translating Sustainabilities between Green Niches and Socio-Technical Regimes'* (Smith, 2007) Adrian Smith highlights the issues of moving an innovation from its embryonic or niche stage and into the mainstream. When discussing the transmission of green skills and training in the UK, Smith cites the example of the CAT in Machynlleth, Wales which operates to provide training to deliver '*green'* building skills and understanding. He argues that while CAT has supported this type of knowledge transfer since the 1970's with intermittent expansion in interest in these skills during the late 1980's, that the skills and understanding have, until recently, largely remained contained within a niche market. Smith

believes this is the case because of poor engagement between CAT and the existing or incumbent regime in the UK –

> *'There was an expansion of these on the crest of the second wave of widespread environmental concern in the late 1980s, and a third wave is currently emerging. But all this largely limits activity to within the niche and while fulfilling a public education role, engages poorly with the regime'* (Smith, 2007)

The argument that engagement between the '*green niche'* and the mainstream or '*regime*' has been sporadically successful to date is also represented in the story of the development of early super insulated buildings in the UK for example in the case of the Energy World Project in Milton Keynes, as also described by Smith.

Innovation Networks

In '*The Diffusion of Innovations'*, Rogers argues that better communication networks enable the diffusion of innovations and that individuals who are linked through better networks are usually good catalysts supporting the dissemination of innovation. However, he makes the case that in order for this communication process to function then the gaps in the network chain need to be bridged. Rogers argues that if communication flows through interpersonal networks, then it is likely in the initial stages to function between homophilious or similar individuals. This can arguably also be supported by the degree of social or cultural capital that exists between individuals or groups. In their paper '*Social and cultural capital in project marketing service firms: Danish architectural firms on the German market*' (Skaates et al., 2002) Skaates et al present findings from research that shows the difficulties that have been experienced by Danish architectural firms who have tried to work in Germany. This is concluded as being due to different work cultures which have impacted upon the ability to generate social capital.

> '*Differences in norms and ways of working would make it more difficult to establish credibility in the interaction mode that is typical of the generation of social capital. If we find that there are few social ties among professional sub-field actors from the two countries and that there are different norms and ways of working in the two milieus, then we will have evidence that social capital is not transferable'* (Skaates et al., 2002).

In situations where actors have little in common or who are heterophilious, communication can be either more limited or occurs through alternative network structures.

Rogers explains that the concept of homophilious behaviour enabling communication and the diffusion of ideas was understood a century ago by Gabriel Tarde, who noted in 1903 that –

> *'Social relations, ... are much closer between individuals who resemble each other in occupation and education'* (Rogers, 2003)

The communication of an idea or an innovation is also dependent upon the type of social system into which it is launched. In social systems that are generally less divided then communication has been observed to be easier. However in systems of greater social division, for example within the Indian caste system, which has functioned as a network of specific hierarchical social groups, then communication has been observed to occur through heterphilious routes which involve those in lower social ranks, waiting to seek high status support for ideas from those in the upper tiers of society, before they adopt the ideas themselves. Rogers argues that this type of social network can result in a slower process of adoption than in a flatter social structure.

An understanding of the society and types of social networks into which an innovation is launched is considered by Rogers integral to helping understand actual and appropriate dissemination methods. This includes for careful consideration of the role of key actors in a system. Rogers explains that a common mistake made by those wishing to communicate new ideas or information occurs in the choice of a change agent or disseminating agents employed who are '*too innovative and who lack the capacity to communicate with the mainstream'* (Rogers, 2003). This can mean that communication gaps are exacerbated rather than reduced, particularly in systems with strong '*traditional norms'* (Rogers, 2003) or that are very conservative. Rogers explains this as follows –

> *'A common error made by change agents is that they select opinion leaders who are too innovative. Change agents work through opinion leaders in order to close the heterophily gap with their clients. But if opinion leaders are too much more innovative than the average client, the heterophily that formerly existed between the*

> *change agent and his or her clients now exists between the opinion leaders and their followers. Innovators are poor opinion leaders in systems with traditional norms'* (Rogers, 2003)

In his book '*Tipping Point'* (Gladwell, 2001a), Malcolm Gladwell discusses the importance of the peer group in the innovation dissemination process, when considering communication processes through networks, and social groups. He cites the research of Judith Harris in her book *'The Nurture Assumption: why children turn out the way they do'* (Harris, 1998) and uses the examples of teenagers who smoke to be like their friends, and of immigrant children not retaining the accent of their parents but adopting that of their peer group to demonstrate this point.

As previously discussed, the ideas-dissemination process is contingent upon social systems but also the physical environment. Gladwell discusses this when he refers to the importance of existing context or physical environment when instigating change. This is demonstrated within the context of the '*broken window theory'* which was developed by criminologists James Q. Wilson and George Kelling and described in the book '*Fixing Broken Windows*' (Kelling and Coles, 1996). Wilson and Kelling believe that crime or dysfunction is an inevitable consequence of certain types of disordered environment. They use the example of a broken window left unrepaired in a building leading to the conclusion of passers-by that nobody cares about the building. This in turn leads to belief that '*no-one is in charge'* (Gladwell, 2001a) so more windows are likely to get broken and thus the spiral continues downwards . This process can also potentially work in reverse: for example if a neighbourhood is cleaned up and kept clean, then people littering will look conspicuous and the process of littering will become unacceptable, thus promoting a certain type of behaviour pattern. This phenomenon could be applied beyond the physical and into the realms of communication with the example of one individual in a company not answering emails eventually leading to an entire culture of non-communication in that company. This may be relevant when considering communication modes from niche innovators and the mainstream.

The above example of the broken window theory reinforces the importance of context and environment when considering behaviour change and the dissemination of ideas and innovations, but also the importance of psychology and perception. It demonstrates that if change is to flourish, then perceived functioning of infrastructure can be as important as actual functioning of infrastructure. If people believe a system is broken through communication of small but significant signals, then trust in that system can be lost and there is the potential for that system to degenerate into one that is in reality fractured or broken. Hence the attempts of those with vested interests to thwart the development of the daylight lamp through attempts to publicise accounts discrediting the product, as previously discussed.

Innovation Variables

It is apparent from cited examples there are many factors which contribute to the development of an innovation all of which may act to speed or hinder its assumed progress. These factors could be described as the variables in the process. Roger's lists independent factors or variables that may affect the innovation process in an organisation or system. These are outlined below –

"Independent Variables

Individual (Leader) Characteristics

1. Attitude toward change

   Internal Characteristics of Organisational Structure

1. Centralisation – '*the more that power is concentrated in an organisation, the less innovative the organisation tends to be'*
2. Complexity – '*the degree to which an organisation's members possess a relatively high level of knowledge and expertise'*
3. Formalisation –*'Is the degree to which an organisation emphasises following rules and procedures in the role performance of its members'*
4. Interconnectedness – '*Is the degree to which the units in a social system are linked by interpersonal networks'*

5. Organisational Slack – '*Is the degree to which uncommitted resources are available to an organisation*'
6. Size

External Characteristics of the Organisation

1. System openness'' (Rogers, 2003)

In the same way that Speirs et al argue that an innovation will only thrive in the context of a cohesive and supportive holistic social environment, Rogers also believes that the variables he lists will affect the innovativeness of an organisation. He argues that if any are disproportionately represented then this will alter its progress and development. Roger's believes that it is the combination of individual leadership characteristics, the component factors making up the internal characteristics of an organisation and the 'openness' or external characteristics of that organisation combined that will affect the '*Organisational Innovativeness'* (Rogers, 2003) or capabilities of that organisation.

When considering the factors that may have key influence over this process, Roger's argues that innovations that require the decision of an individual for adoption tend to progress at a faster rate than those that initially require a collective or group decision. He therefore believes that one way to speed up the process of adoption of an idea could be to focus on a few individuals. He describes this thinking below -

> *'The more persons involved in making an innovation-decision, the slower the rate of adoption. One means of speeding the rate of adoption of an innovation is to attempt to alter the unit of decision so that fewer individuals are involved.'* (Rogers, 2003)

The success however of this type of strategy would be dependent upon the connectivity of the individuals and the degree to which they are '*networked*' to other responsive individuals. In the book '*Six Degrees'*(Watts, 2004), Duncan J. Watts explains that the successful transmission of a request or idea also depends upon a robustly connected system and the optimum functioning of each connective node.

'*The successful transmission of a request depends on every node in the chain performing its information-processing duty'* (Watts, 2004)

In the example of a '*traditional*' hierarchical distribution system, nodes that sit higher up in an information chain are better connected to more other members of that system but are burdened with greater information channels by which to communicate. There may be fewer nodes or individuals at the top but if all information has to pass through them, then there is the potential for stress causing delays or rupturing of the system. Watts argues that this type of system is quite vulnerable to the removal of a node which would potentially stop information flow. A common demonstration of where this process of purely hierarchical '*top-down'* dissemination of information has been shown to fail has been in the example of new companies or organisations which are strongly reliant on people as a resource. When these new companies expand there is the potential that with the departure or addition of new people will result in the migration or loss of capabilities (Christensen, 2003). The same problem can be apparent in social marketing situations and other physical distribution systems such as in grid power distribution for example when the removal of a node can result in the break-down of all or part of that system.

In Six Degrees, Duncan Watts uses the physical case study of the New York power black-out of 1977 to demonstrate this point. In this example the city of New York experienced a total power outage for a number of hours which caused social mayhem with a resulting bill of about $350 million dollars. This was caused by a series of mistakes and subsequent failures between linked regional grid electricity supply grids (Watts, 2004). These collapsed in a domino effect resulting in complete power failure throughout New York.

This example and those cited previously help to demonstrate the complexities that exist when considering the success of distribution or diffusion networks, with how they are governed, the internal and external factors and breaks in networks often acting to compound any system errors. Understanding all the potential processes that may be at play in a system will depend upon its size, construction and levels of connectivity between component parts. It will also depend upon the context into which it is placed or emerges and the nature of individuals operating within it.

In the case of human networks and the dissemination of innovation, knowledge can be shown to remain in a system through the generation of a specific culture that supports an understanding of this knowledge. This enables a more robust system that is not so reliant on individuals. The development of the Passivhaus standard in Germany has appeared to have followed this type of system development pattern and has resulted in the development of associated supply chains and culture. If the Passivhaus standard is to thrive in the UK, adherence to similar structured dissemination systems would probably be appropriate.

Summary and Passivhaus

The processes that surround and enable the development of an innovation are complex. They involve factors that relate to the quality of the technology, the social and cultural systems into which it is launched, available economic support and its appropriateness for a specific market.

Success of an innovation is also contingent upon individuals supporting it and their role within specific communication chains together with the perceptions of those who engage with or who are confronted with them. Success ideally involves nurturing the innovation and developing appropriate strategic mechanisms for its dissemination. An understanding that the needs of early innovators will be very different from the majority or mainstream market is also very important.

Understanding the processes that enable the communication of a new idea or innovation involves attempts to predict how that innovation could develop over time, thus allowing foresight to locate any obstacles that may stand in its way. These obstacles may relate to threats to existing cultures and livelihoods, but also to overriding environmental impacts such as drain on resources that are needed to support the innovation. The implications relating to resources are linked to both physical and human potential and their availability within the supply chain or '*technology cluster'* surrounding the innovation.

Innovations and ideas tend to evolve over time and this can be in a non-linear direction of progression. In order to gauge innovation potential an understanding needs to be gained as to the extent that time is likely to be a factor in the process and the 'fixed' nature of an innovation in terms of where it is situated in terms of stabilisation or closure. In conjunction with this it is of vital importance to consider the socio-political context into which the innovation is to develop together with social engagement methods to be used as part of the development process. These can include identification of relevant supportive individuals.

In Germany the Passivhaus standard has been acknowledged by some key and influential political figures and scientists such as Ernst Ulrich von Weizsäcker who is a former member of the recent '*rot-grünen'* or '*red-green'* coalition government in Germany and a key supporter of green energy reforms and efficiency measures -

> *'Er fordert seit Langem eine Revolution der Energieeffizienz* (Laible, 2010b).

My translation into English is -

> *'He has long promoted a revolution in energy efficiency'*

As such he is the type of person who has the capacity to influence large number of people and act as an opinion leader and potential change agent. Currently von Weizsäcker lives in a Passivhaus home near Freiburg, south Germany. Although it is not clear if this fact has directly influenced the uptake of the Passivhaus standard in Freiburg or in Germany, this support may have worked to raise the profile of the standard and the Passivhaus Institut.

Passivhaus a Brief History

'The Devil is in the Details' – often attributed to Walter Gropius

Introduction

According to Wolfgang Feist from the Passivhaus Institut in Darmstadt, a Passivhaus is a building where -

> *'The heat losses of the building are reduced so much that it hardly needs any heating at all. Passive heat sources like the sun, human occupants, household appliances and the heat from the extract air cover a large part of the heating demand. The remaining heat can be provided by the supply air if the maximum heating load is less than 10W/m^2 of living space. If such supply-air heating suffices as the only heat source, we call the building a Passivhaus'* (PHI and iPHA, n.d.)

According to the UK Passivhaus Trust, based on the design parameters set out by the Passihvaus Institute in Darmstand, building to the Passivhaus standard in the UK requires the following -

'The Passivhaus Standard requires:

- *A maximum space heating and cooling demand of less than 15kWh/m^2 a. or a maximum heating and cooling load of 10W/m^2*
- *A maximum total primary energy demand of 120 kWh/m^2a.*
- *An air-change rate of no more than 0.6 air changes per hour @ 50 Pa.'*

Achieving the standard in the UK typically involves:

- *'Very high levels of insulation*
- *Extremely high performance windows with insulated frames*
- *Airtight building fabric*
- *'thermal bridge free' construction*
- *A mechanical ventilation system with highly efficient heat recovery'*

And

'Certification:

The Passivhaus Institut has developed a number of certification processes to ensure the quality of any official Passivhaus buildings and practitioners:

- *The Passivhaus Planning Package (PHPP), used to inform the design process and to assess or verify compliance with the Passivhaus standard*
- *Certification for designers who have the expertise to deliver Passivhaus buildings*
- *A Certification process for Passivhaus buildings, which applies both to the proposed design and the completed building'* (Passivhaus Trust, n.d.).

Although the Passivhaus standard was developed in Darmstadt in Germany it has roots in the evolution of super insulated buildings in North America, the United Kingdom and Scandinavia during the past 70 years.

The motivations to create super insulated, low energy buildings can be traced back to specific times or situations when there have been shortages or stresses on energy supplies and materials, for example after the 1973 global oil shock. However the context for the development of more efficient buildings also lies during times of marked technological changes or progression. Thus the evolution of low energy building designs has been contingent on political, social and technological factors combined.

During the 1970s and 1980s Europe saw the development of many low energy building projects. Potentially due to colder climate, the development of super insulated low energy housing progressed further in Scandinavian countries, particularly Sweden. At the beginning of the 1980's the LEH (Low Energy House) or NEH (Niedrigenergiehaus - as it is known in German), were first demonstrated in Sweden, where this design was used to form the basis of the *Nybyggnadsregler* or low energy building design standards.

The Nybyggnadsregler were later developed into the mandatory standard for the Swedish Building Regulations and implemented as a national standard in 1991. The target for space heating performance for this regulation is 70kWh/m^2 a. At the end of the 1990s this standard was brought to Germany as a complimentary good practice standard for low

energy building design in addition to the building regulations. The German building regulations vary slightly between each German state but since 1st February 2002 have been supported by a standard generic building code (Dewsbery, n.d.) and later EU policy in the form of the EPBD (Energy Performance of Buildings Directive: known in Germany as the EnEV(Energieeinsparverordnung). This was implemented in Germany in 2009 (DENA, n.d.).

At the end of the 1980's Professor Wolfgang Feist from the University of Darmstadt and Professor Bo Adamson from Lund University in Sweden decided to try and perfect the design of the super insulated house to create an affordable low energy building design standard that would consistently deliver energy reduction targets and perform better than Nybyggnadsregler housing. From the start of the project the building physicist Wolfgang Feist stated his and the team's intentions which were to try and understand the failings of many existing low energy super insulated building designs and develop a simple and workable standard that would be suitable for different construction types and climates in Europe and worldwide.

Passivhaus: Kranichstein

The first project to develop the Passivhaus standard was initiated at Darmstadt University in the state of Hessen in Germany. A scientific working group was set up for this project as part of the IWU (Institut für Wohnung und Umwelt – *Institute for Housing und the Environment*) from the HMWT (Hessischen Ministerium für Wirtschaft und Technik - *Hessen Ministry for Industry and Technology*). This project was funded and directed by the state government of Hessen and influences for the project were drawn from designs of early super insulated housing in the US and other parts of Europe. The design work was also supported by the American architect Robert Hastings who had previously worked on many super insulated housing projects in the US.

The actual project comprised the building of four family homes each with an area of 156m^2, making up a small row of terraced houses in Kranichstein, Darmstadt. This project has since become known as the '*Experimental housing Darmstadt Kranichstein K*7' (Feist, 2006) project.

The architects for the K7 project were Professors Bott, Ridder and Westermeyer working together with Professors Wolfgang Feist and Bo Adamson. The aim was to produce inhabited homes with as near to zero heating requirements as possible. They were designed with the following fabric and MVHR performances -

Roof	U-value 0.1 W/m^2 K
Wall	U-value 0.14 W/m^2 K
Cellar Slab	U-value 0.13 W/m^2 K
Triple Low-e Glazed Windows	U-value 0.70 W/m^2 K
MVHR efficiency	80%

(Feist, 1997a)

Figure 3 - Table of design parameters for Kranichstein Passivhaus dwellings

In addition to the above fabric performance specification, the buildings utilised on-site solar thermal panels to supplement domestic hot water heating and ground source heat pumps. After construction the housing was tested in relation to air-permeability using blower-door tests. The average air-permeability of the housing was found to be 0.3 -1 @ 50 Pa and thermographic images showed that the construction was thermal bridge free as per design intention. The initial test results and thermographic records were written up to produce the seminal report '*The Passivhaus Darmstadt Kranichstein'* (Feist, 1997a) which is now distributed via the Passivhaus Institut in Darmstadt.

The housing was initially extensively monitored with data being continuously gathered by EBÖK (Ingenieurbüro für Ökologische Konzepte). The data was analysed to produce annual energy consumption figures for the years 1991 – 1995, starting in October 1991 and ending in September 1995. Further testing has also been carried out on this project beyond this date.

To gain energy consumption figures and further understanding of the performance, the four houses were tested in relation to and for the following factors –

- Climate (outside air temperature and humidity, wind speed and direction, solar irradiation)
- Indoor air temperatures (in all houses and in all rooms)
- Indoor air humidity (House IV in all rooms)
- Radiator temperature (House IV in all rooms)
- Temperature cross-section and heat flow in wall
- Temperature cross-section and heat flow in roof
- Surface temperatures of windows
- Status of insulating sliding shutters
- Air flow rates of ventilation system (and temperature and humidity)
- Flow rates and temperatures of cold water, rainwater and hot water
- Heat metering of heating, hot water, circulation and solar collectors

The following additional tests were also undertaken –

- Thermographic assessment of building fabric
- Air-pressure tests
- Tracer gas tests to understand ventilation efficiency

The results of the testing showed that the housing performed very much as predicted. The average annual heat requirement for the dwellings over five heating periods was shown to be less than 10kWh/m^2 a., with an average maximum heating load of 7W/m^2. In conjunction to this, the total specific end-use energy requirement for supplementary heating, domestic hot water, ventilation and household electricity was lower than 33kWh/m^2 a. This slightly exceeded design targets of 30kWh/m^2 a. When these figures were compared with German standard national energy use figures, they equated to final energy savings of approximately *'90% and with 78%'*(Feist, 1997a) compared to contemporary new homes at the time.

Key findings from the initial test results showed that despite the fact that the houses were designed with radiators and space heating, it was possible to provide heating for these dwellings using only the air supply from the MVHR. It was however concluded that the efficiency of the MVHR units was integral to the overall success of the performance of the buildings and provision of thermal comfort.

Monitoring and testing results also showed that these houses performed well in terms of both occupancy comfort and overall energy performance. The results from testing also showed that the maximum designed space heating requirement should be no more than 10W/m^2 and that the use of the triple low-e krypton filled glazing was found to be effective and important for providing occupancy comfort and heat loss through maintaining internal surface temperatures in the building, in conjunction to providing energy savings. The occupants of the houses were all found to be satisfied with the performance of the housing and comfort levels in both summer and winter. It was found that key to this housing's success was careful planning and attention to quality assurance during construction. This was also vitally important for delivery of the required building fabric performance.

The overall build cost of the Kranichstein housing was 50% more than conventional housing built during this time in Germany. This cost was absorbed by the Hessen environment ministry who understood it to be the necessary cost for developing prototype low energy housing. The development of the housing directly led to the advancement of various building products associated with the construction of Passivhaus buildings such as triple-glazed windows and high efficiency MVHR systems (Feist, 1997a).

The results from the testing of the K7 project were used to feed into the design of a proposal and performance specification for the CEPHEUS (Cost Efficient Passive Houses as European Standards) programme in 1997. The intention of the CEPHEUS programme was to develop a low energy, low cost building standard for Europe.

The development of the housing at Kranichstein attracted significant international attention, inclusive from the energy efficiency pioneers Amory Lovins and Ernst von Weizsäcker who used the Kranichstein development as a case study in their book '*Factor Four*' (von Weizaecker et al., 1998)

Amory Lovins commented enthusiastically about the development at Kranichstein since he believed that Passivhaus had the potential to help solve the pending global energy crisis and

stave off the effects of global warming. Lovins commented on the Kranichstein project by saying -

> '*No, this is not just a scientific experiment. This is the solution. You will just have to redesign the details in order to reduce the additional costs – and that will be possible, I am convinced*'
> (von Weizaecker et al., 1998)

CEPHEUS – (Cost Efficient Passive Houses as European Standards)

After the successful development and monitoring of the Kranichstein test housing, a proposal was put to the European Commission, Directorate-General, XV11 in 1997. This proposal was known as CEPHEUS and its aim was to build 239 dwellings to the Passivhaus standard (as devised from the testing of the four Kranichstein homes) in six different European countries. The intention was to test all these homes and use the results to form the basis of a pan-European standard for affordable low energy homes. The CEPHEUS proposal defines Passivhaus homes as follows -

> *'Passive Houses are buildings in which a comfortable interior climate can be achieved without an active heating and air-conditioning system. To permit this, the specific annual heating demand for space heating must be kept lower than 15 kWh/m^2 a. and the total final energy demand for space heating, domestic hot water, ventilation and household electricity must not exceed 42 kWh/m^2 a. This forms the basis to cover the remaining energy requirement by renewables.'*(CEPHEUS, 1997)

The proposed countries where the CEPHEUS housing was to be built and the location and number of dwellings for each was as follows –

1. Sweden, Göteburg - 10 dwellings
2. UK, Derwentside and Leominster – 10 dwellings in total between the two sites
3. Germany, Hannover 140 dwellings
4. Austria, Vorarlberg – 24 dwellings
5. Switzerland, Luzern – 15 dwellings
6. France, Rennes – 40 dwellings

All the homes were designed to be occupied as conventional housing, but tested and monitored for overall energy performance. One home per country was made permanently available for further testing for purposes of viewing by the general public. All those participating in the CEPHEUS project had to agree to form part of an International CEPHEUS panel to communicate the results of their projects and to meet on a bi-annual basis to discuss their findings. The results of testing gathered up until 2000 were then presented at the EXPO 2000 World Fair in Hannover. The location of the German housing in Hannover also formed part of the EXPO 2000 fair and allowed visitors from all over the world to view Passivhaus dwellings there.

The CEPHEUS homes were built to the following specifications (CEPHEUS, 1997) –

Figure 4 - Table of design parameters for CEPHEUS housing

Component	***Characterisation***	***Specification***
Building Fabric	*Super insulated*	*U-value around 0.1 W/m^2 K*
Building Element Connections	*Reduced thermal bridges**	*U-value around 0.0 W/m^2 K*
Airtightness	*Closed building fabric*	*n50 around 0.5 ac/h*
Subsoil heat exchanger	*Supply air preheating*	*Supply air over 8˚C*
Hygienic ventilation	*Directed air flow through whole building; exhaust air extracted from damp rooms*	*Total around 140 m^3/h*
Heat recovery	*Counter flow air-to-air heat exchanger*	*n>80%*
Latent heat recovery from exhaust air	*Compact heat pump unit for water heating*	*Max. Heat load 1000 Watt. Annual COP > 3 monovalent system*
Passive utilisation of solar energy	*Optimised glazed areas*	*Approx. 40% coverage of space heating requirement*
Super glazing	*3-pane low-emissivity glazing*	*U-value < 0.7 W/m^2 K – g-value> 50%*
Super frames	*Super insulated window frames*	*U-value < 0.8W/m^2 K*
Solar flat plate collectors	*Integrated in facade*	*> 50% coverage of water heating*
Household appliances	*High-efficiency low-energy household appliances*	*Savings of over 50%*
Supply of remaining energy	*Only Hannover-Kronsberg project:*	*100% demand coverage over*

demand from renewable sources	*share in wind power facility*	*annual average in Hannover*

*The specifications listed in the table above (Figure 4) are taken directly from the UK CEPHEUS proposal document from 1997. It was to these specifications that the housing for the project was built. Clarification in relation to the specification for a reduced thermal bridge free construction was also included in this document and is described as follows –

> *'All connections will be optimised with the objective of minimising thermal bridges at economically acceptable cost. The goal of thermal bridge optimisation is to reduce the additional linear or point-shaped bridges to the geometrically unavoidable level: with reference to the outer surface, the thermal bridge loss coefficients are then close or equal to zero'* (CEPHEUS, 1997)

In order to maintain the integrity of the low energy and environmental impact performance of the CEPHEUS Passivhaus dwellings it was understood that the energy load for all electrical appliances and any additional space heating should be kept to a minimum, hence the requirement that the specific energy load, under normal conditions of occupancy, should not exceed 42 kWh/ m^2 a.

The cost of building the houses was a key factor in the development of the CEPHEUS dwellings. The initial intention for the project was to produce housing that was cost efficient and that included for initial investments in 'passive' technologies that would not equate to more than the energy savings from running the housing over a 30 year period. There was also an emphasis, where possible, on the use of efficient equipment and appliances and pre-fabricated building products.

Cost benefits for the development of the CEPHEUS housing were seen in terms of the long term future but also occupancy comfort. The UK section of the original CEPHEUS proposal explained the potential that the development of the Passivhaus dwellings could have to impact on the house-building industry and wider environmental and energy saving targets in the UK as follows -

'We believe that the Passive House would make it possible for the house construction industry to build commercially a significant number of Passive Houses by the year 2005. Our calculations show that the early introduction of the Passive House concept can reduce carbon dioxide annual emission rate by up to 11 million tonnes per year, by the year 2020. Cumulative savings, by the year 2020, would be up to 100 million tonnes of carbon dioxide, and £10 billion of expenditure on energy. The savings would make a major contribution to the long term carbon emission reduction targets announced by the Secretary for the Environment in June.' Robert Lowe (CEPHEUS, 1997)

As with the Kranichstein housing, the design of the CEPHEUS dwellings sought to use renewable energy technologies only when the overall heating and energy loads had been reduced through fabric performance and other energy efficiency measures such as the use of low energy appliances had been implemented. This thinking is described in the initial proposal for the CEPHEUS programme. It was intended that this concept be demonstrated in the Kronsberg housing which formed part of the EXPO 2000 fair in Hannover. This housing was linked to wind turbines located near to the development which also formed part of the EXPO -

'Concepts that primarily rely upon additive active systems for the renewable satisfaction of a still relatively high energy demand, or strive for full independence from outside sources, will most likely only be realisable with substantial subsidisation for the foreseeable future, and will thus not be generally viable in the market place. This also has to do with the fundamental physical fact that particularly solar energy is only available with low density, and in supply over time that does not coincide with demand.

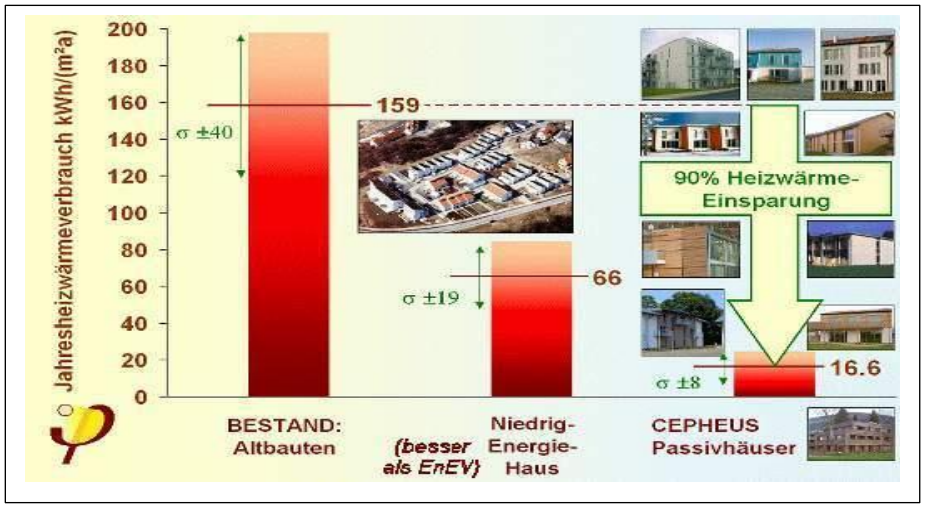
This is further aggravated by the problem that the quantitative availability of renewables, too is limited due to both natural circumstances and due to competing demands upon the use (or non-use) of natural resources. It is thus a generally accepted principle that the drastic reduction of energy demand is a decisive

precondition to any greater proportion of renewables in the total energy supply.'
(CEPHEUS, 1997)

Strategically the development of the CEPHEUS housing was aimed at showing the technical feasibility and cost effectiveness of construction of Passivhaus dwellings in different European countries, thus allowing for different climatic conditions, construction traditions and skills cultures in the EU. It was also intended to test the '*investor/purchaser'* acceptance of Passivhaus dwellings and provide a show case of housing that could be viewed by architects, designers, engineers and members of the public alike. It was also the intention that the project would work as a catalyst for the development of additional low energy housing and building schemes, programmes and designs throughout Europe.

All the CEPHEUS housing was monitored and tested for its energy performance and acceptability in terms of occupancy comfort. The housing performed very well and met with most design expectations. On average space heating requirements were reduced by 90% against standard German housing. Significantly this was found to be the case throughout all the different developments in all the countries with the overall range of results being very small showing a deviation of only 8%. (CEPHEUS, n.d.). See Figure 5.

The results from testing all the housing were used to feed back into the production of the PHPP (Passivhaus Planning Package) software that is now used to design Passivhaus standard buildings. Testing undertaken on Passivhaus buildings constructed post CEPHEUS has also informed further iterations of PHPP which makes up the basis of the Passivhaus standard today.



(PHI and iPHA, n.d.)

Figure 5 - Results of CEPHEUS testing

The Super Insulated House – A Brief History

The first super insulated houses were built in North America and Canada in the early 1970's shortly after the 1973 Oil crash. These designs were influenced by research undertaken from as early as the 1920s and 30s carried out by the University of Illinois, where exploration had been undertaken into the potentialities of gravity convection flow of hot and cold air in houses. Further research work had also been undertaken at the University of Illinois in 1944 into methods of improving insulation in homes. This research led to the formation of the Small Homes Council (SHC) and the eventual development of experimental test housing. Some of the research undertaken by the SHC was published at this time in journals and books produced by ASHRAE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers), who are partly responsible for setting standards for the design of building services and building performance in the US today.

In his book '*Super Insulated Houses and Double Envelope Houses'* (Shurcliff, 1981) William Shurcliff describes how the name '*super insulated'* was chosen to describe early low energy homes after deliberation with alternatives such as the '*micro-load'* house and the '*autonomous*' house were rejected due to perceived negative political associations.

The term super insulated was eventually chosen as being –

'not an ideal name, but ...good enough'(Shurcliff, 1981)

Shurcliff defines a super insulated house as being –

> *' ...a house that is situated in a cold climate (4000 degree days or colder) and: receives only a modest amount of solar energy (for example, has a south-facing window area not exceeding 8% of the floor area) is so well insulated, and is so airtight, that, throughout most of the winter, it is kept warm solely by (a) the modest amount of solar energy received through the windows and (b) miscellaneous within-house heat sources (intrinsic heat sources). Little auxiliary heat is needed: say less than 15% as much as is required by typical houses that were built before 1974 and are of comparable size.*
>
> *By 'miscellaneous heat sources within the house' I mean these intrinsic internal sources:*
>
> *Stoves for cooking*
> *Domestic hot water systems*
> *Clothes dryers*
> *Electric lights*
> *Clothes washing machines*
> *Dish washing machines*
> *Human bodies*
> *TV and radio sets*
> *Refrigerators*
> *Other electric devices (in kitchen, living areas, workshops, etc.)'* (Shurcliff, 1981)

In this definition of a super insulated house, the auxiliary heating required would have been provided from either an oil or gas boiler, an electric space heating system, heat pump or wood-burning stove. The total auxiliary heating would not have met more than 15% of

relative heating requirements for a conventional house built in or before 1974, since it was found that the super insulated house would remain warm during the majority of the winter months with internal temperatures never dropping below 32˚F (0˚C). This meant that the house could remain comfortable and pipes would not need to be drained in winter since they would not freeze, (a factor which was normally a typical problem associated with cold climate housing in the winter months).

The requirement to limit the window area on the south facade to not more than 8% of the total floor area was chosen to regulate the amount of solar energy from passive solar gains together with heat loss from glazed areas, thus allowing more stress to be placed on conserving heat emissions from internal casual loads from the miscellaneous heat sources.

The North American super insulated homes used the basic design principles as outlined in Shurcliff's book. At the end of his book however, Shurcliff remarks on potential refinements to the design principles and the additional performance benefits that could be gained from employing thermal mass, a high-COP (Co-efficient of Performance) air-conditioner and a solar collector to supplement the design performance of a super insulated house -

> *'A radically new method of supplying supplementary solar heat to super insulated houses-with-basement may convince owners of such houses that there really is a Santa Claus. The proposed method, designed to provide a moderate thermal boost and large carry-through, employs*
> *(1) an enormous thermal mass – the basement itself maintained at 60 to 75˚F*
> *(2) a high-COP air-conditioner to upgrade the transfer heat from the basement to the rooms, and*
> *(3) a small, cheap, air-type solar collector to replenish the basement's heat on sunny days.'* (Shurcliff, 1981)

Early examples of super insulated houses in North America are the Lo-cal House and the Saskatchewen Conservation house.

The Lo-cal House was built in 1976 after extensive research undertaken by the SHC. It was developed by a faculty team of architects and engineers inclusive of Professors Warren S. Harris, Rudard A. Jones, Wayne L.Shick and Seichi Konzo. This team built several test developments and issued publications detailing their performance and also recommended construction procedures.

> *'By 1971 Konzo had become convinced of the need to improve the insulation of ceilings and roofs, and make further improvements, which included optimisation of the distribution and sizes of windows. They designed a super insulated house (Illinois House) and tried to persuade ERDA (US Energy Research and Development Administration) to fund the construction of such a house. (ERDA declined.)'* (Shurcliff, 1981)

The initial development of the Lo-cal House evolved into a family of four designs known as A, B, C and D type houses which were considered by Shurcliff to be influential in the development of many super insulated dwellings in the US .

The Saskatchewen Conservation house was built in 1977 by the Saskatchewen Research Council with the architect Hendrik Grolle. The project was managed by David Eyre and supported with research assistance from the National Research Council Division of Building Research, the University of Saskatchewen Department of Engineering, the University Of Regina Faculty Of Engineering and the Saskatchewen Power Corporation. This timber frame building was monitored for its performance from January 1978 with the production of significant data. Despite the fact that this was a test house, with thousands of people visiting it, the house performed to expected energy reduction targets.

> *'...in the period since monitoring was started, (Jan. 1978), R.W. Besant et al of the Mechanical Engineering Department of the University of Saskatchewen have amassed much interesting information.*
> *The annual amount of heat needed over and above what is supplied by intrinsic heat sources, passive solar heating, and active solar heating is: none. In other words the percent-solar-heated figure is 100%.'* (Shurcliff, 1981)

The following is a table devised by Shurcliff in which he describes the general performance of super insulated houses against specific criteria –

Figure 6 - Shurcliff's findings in relation to the performance of the super insulated house

'Category	***Super Insulated House***
Greenhouse (conservatory)	*Has none. A greenhouse would lose much heat at night and thus greatly impair performance*
Requirements as to full exposure to sun in winter	*Moderate exposure may suffice. Only a moderate amount of solar energy is needed*
Comfort in winter	*Excellent*
Rate of air change in winter	*May sometimes be too low or almost too low. Use of air-to-air heat exchanger may be necessary*
Access from south rooms to south lawn	*Direct access is easily provided*
Access from south rooms to south air and sky	*Direct. Merely open south windows*
Requirements as to large thermal mass	*No requirement. There are no sudden large energy inputs or sudden large loads*
Amount of auxiliary heat needed	*None. Almost none.*
Wood stove or equivalent	*Not needed*
Amount of enclosed volume that is not kept warm at night	*Practically none. Only the attic space is cold.*
Spaces accessible to animals and children but not to adults	*None.*
Spaces requiring fire-stop dampers	*None.*
Cost of thermal shades – if they are needed	*Small. Windows are small. (Perhaps shades are not needed)*
Large vents in gables (for summer use)	*Not needed. There is no big heat load to dissipate*
Cooling requirement in summer	*Little cooling needed. Outdoor air cools rooms at night. On sunny day house is kept closed and eaves block direct radiation.*
Size of air conditioner needed on hot test days	*One small conditioner suffices.*
Privacy	*Excellent. Windows are small and sills are high above ground.*
Attraction to vandals	*Small. See item just above.*

Durability and ease of maintenance	*Can be excellent.*
Incremental cost of super insulation	*Said to be small: about 0 - $2000 – small because saving re furnace etc. almost cancels cost of extra material and labor.'* (Shurcliff, 1981)

After the development the Lo-cal House and the Saskatchewen Conservation House a number of super insulated houses were constructed in the US and Canada inclusive of the Roggasch House in Fairbanks Alaska, the McCulley and Laz Houses at Champaign in Illinois, the Kirkwood House at Cedar Rapids in Iowa and the Super insulated Dome in New Mexico. William Schurciff makes the following estimate of numbers constructed up until 1980 in his book -

> *'Estimates made by friends suggest that by August 1980 as many as 50 or 150 super insulated houses had been completed and 500 to 1500 others were under construction'* (Shurcliff, 1981)

Where these examples were tested, data has indicated that they performed well and reduced space heating demands. They were also shown to be relatively inexpensive to build with additional costs in the region of 10-15% above conventional build costs for housing (Shurcliff, 1981)William Shurcliff tables his delight in the simplicity of super insulated houses in this quotation from his book below -

> *'I am wholeheartedly enthusiastic about super insulated houses. They are simple and inexpensive, and they seem fully understandable and fully successful. (Sometimes I feel that they are so very simple and understandable as to be no fun! Surely mystery and complexity add zest to our lives?* (Shurcliff, 1981)

Wates Conservation House, The Centre for Alternative Technology, Machynlleth, Wales

The publication '*Energy and Buildings at the Centre for Alternative Technology, Technical Information Report No. 1*' (Todd, 1979) by Robert Todd documents the development of the

super insulated house, Wates Conservation House which was built, on site, at the Centre for Alternative Technology in Machynlleth, Wales between 1975 -1976.

Wates Conservation House was funded, built and supported by the UK home builder and contractor '*Wates Built Homes'*. It was developed as a demonstration project to show what could be achieved in terms of low energy building performance using existing building technologies. The house was designed by architects Peter Bond Associates with the remit to be built to '*a fairly conventional appearance and size'* and within a budget of *'£20,000'* (Todd, 1979).The aim was to concentrate efforts on reducing energy demand rather than supplying additional energy from external sources such as on-site renewable energy technologies. The intention was to initially maintain a grid connection so as to ensure that the house would be an appropriate example for many different locations.

The house was built to be used as a demonstration house so as to stimulate public interest in low energy housing but also to gain research data into the experiences of building with high levels of insulation and using heat pump technology.

As with the North American super insulated houses, Wates Conservation House employs a high level of insulation which encases the building from the walls through to the roof and continues beneath the ground floor. This is the same principle as is also used for Passivhaus designs today.

In common with the early North American super insulated homes, the Wates Conservation House has a small glazed area but uses quadruple rather than double or triple glazed windows. Due to the high degree of air-tightness, this house employs '*mechanical ventilation' (sic)*(Todd, 1979) and is designed with a high level of thermal capacity to take advantage of incidental gains and with the intention to control potential local overheating. The internal air temperature was designed to be 18˚C and a heat pump was used for the domestic hot water supply.

The Wates Conservation House was built with the aim of minimising energy use for space heating but also energy for cooking and lighting with the house being designed to use '*low*

energy lighting appliances' (*sic*)(Todd, 1979). Water supply is supported through the use of rainwater harvesting from the roof, with the water being filtered and used for all purposes within the house with the exception of drinking.

Unlike the North American super insulated houses which frequently use timber frame construction methods, the Wates Conservation House is built using the cavity wall construction technique. The outer skin is brick and the inner skin is Thermalite block with the 450mm cavity filled with '*Dritherm*' glass fibre insulation. The outer wall which is internally buttressed is tied to the inner wall at the buttresses with the insulation being laid in vertical planes allowing condensation to run down them. The calculated U-value for the walls is '*0.075W/m^2 K'. (sic)* (Todd,1979).

The roof uses 450mm insulation in a naturally ventilated space with a vapour barrier beneath the insulation. Todd outlines that some problems were experienced with this demonstration house specifically in relation to levels of condensation in the roofing felt.

The calculated specific heat loss rate for the house was '*66W/˚C' (sic).*(Todd, 1979) and the peak heating demand was measured at 1.2 kW. When loads from incidental gains were taken into account this reduced to an average of 8kWh/day or as stated by Todd, (without typo correction), *'8 kW/day*' *(sic)* (Todd, 1979)in December and January with about 950 kWh *(sic)* (Todd, 1979) over the entire heating season. This is as compared to about 13,000 kWh for a conventional house of the same size built at the same time, or a reduction to less than 10% of conventional space heating demand.

Space heating was provided using an air to air heat pump with the intention that this could also be reversed to allow for summer cooling if necessary. During the hot summer of 1976, the house remained comfortable and did not require cooling from the heat exchange unit. The unit did not however provide sufficient warmth during the coldest periods to provide a comfortable internal temperature, therefore additional space heating was installed with a propane fired gas boiler installed outside the house linked to two internal radiators. The high degree of insulation did however reduce the need to distribute the heat around the house with only the '*two radiators'* (Todd, 1979) required.

Since its construction, the Wates Conservation House has been converted into offices and a demonstration exhibit. Anecdotally it is said that it was difficult to live in this house for a long duration of time, however the dwelling still functions operationally as offices and a display house at CAT.

Milton Keynes

The development of low energy housing and super insulated housing in the UK is also linked to the development of new towns such as Milton Keynes.

At the end of the 1960s before any general political acknowledgements of climate change, but with an awareness of the fragility of geo-political events surrounding oil supply and before the on-set of mass gas central heating installations in UK homes, the development of new towns such as Milton Keynes offered the potential for new thinking about the way we heat and power our homes.

Milton Keynes which had its inception as a town in 1967 developed its first master plan in 1972 with the aim of being one of Europe's and the UK's most energy efficient cities. Strategies were employed as part of the design of Milton Keynes to try and minimise overall energy use from homes, the work-place and transport. Key developments of experimental low energy housing were initiated in Milton Keynes such as the Bradville Solar House, The Linford project, Summerhayes and the Pennylands developments. Thus the precedent for the development of experimental low energy housing in Milton Keynes was set, with this being continued in to the 2000s.

As part of the low energy housing projects built in Milton Keynes, developments which combined the use of passive solar design principles and high levels of insulation were built, these included projects such as 2 Mile Ash which was built using a kit of parts from Finland and used triple-glazed 'low-e' windows together with mechanical ventilation with heat recovery and high levels of air-tightness, similar to north American super insulated homes.

Milton Keynes is also the location of the Energy World development of 51 low energy homes located in the Shenley Lodge area of the city. This project was supported by the UK Construction Industry Council. (Smith, 2007)

The Autonomous House

In response to information presented at the UN Conference on the Environment which was held in Stockholm in 1972, Alexander Pike and John Frazer who were teaching architecture at Cambridge University in the UK, set up a research unit to design and develop buildings that could function as '*independent, ecologically autonomous units'* (Peder, 2010). As an extension of Alexander Pike's work Brenda Vale, who was one of his students, set up her own community the '*Soft Technology Research Community*' on a farm in Montgomeryshire, Wales. The aim of the community was to explore the development of affordable, low energy buildings that used passive solar design principles and did not lose heat. The result of this experimentation was the production of a house which was built by Brenda and her husband Robert which was known as the '*Autonomous House'* because it was not linked to either grid electrical supplies or mains water and drainage systems and instead acted as a '*closed ecological system'* (Peder, 2010).

This project was considered of specific interest at the time because of the fact that it also used technology that had been applied during space exploration such as hydrogen and oxygen fuel cell units.

In contrast to other approaches used in the development of many autonomous communities, which the Vales saw as being 'dr*op-out centres for those of independent private means'* (Clarke and Clarke, 1974) that had evolved at a similar time in the US and UK, the Vales saw their community as being '*important to the survival of mankind*' (Vale and Vale, 1975) especially in the event of any kind of environmental disaster inclusive of that created by global resource depletion, '*war or nuclear attack'*. (Vale and Vale, 1975)

The Hockerton Housing Association

The development of the Autonomous House provided Brenda and Robert Vale with the means and understanding to develop the housing which formed the Hockerton Housing Association. The Hockerton Housing association is situated on a 25 acre site just outside the village of Hockerton in rural Nottinghamshire. It consists of five earth-sheltered houses and was developed by members of the Hockerton Housing Project, inclusive of the Vales, from 1993.

The aim of the project was to build sustainable low energy housing that would have low or minimal environmental impact. The houses were designed to be part of a community that would use home grown and locally produced food and fish that had been farmed as part of the project. The aim was also to develop ecological and environmental businesses on the site.

Despite an extensive and prolonged struggle with local planners, the Hockerton housing project gained planning permission in 1996. This permission was considered historic since this was the first post war sustainable housing project that gained permission to be built on agricultural land. The housing was however only granted permission on condition of a Section 106 planning agreement which stated that it would also provide –

> "*... a real and substantial connection between the occupants and the co-operative".* (HHP, 2002)

This meant that there was a requirement for those living in the housing to set up a legal agreement binding them into the co-operative.

Funding for this project was also unusual in that lending to supplement the housing association's own money was obtained from the alternative bank the Co-operative Bank and the Ecology Building Society, since more conventional lenders were frightened by the self-build nature of the project.

Brenda and Robert Vale acted as the architects for the housing choosing a modular construction system for ease of building and to reduce costs. In terms of energy

performance the housing was designed to be '*net zero-energy'*(HHP, 2002) and thus employ the use of on-site renewable energy systems to supplement an efficient fabric performance which would limit the need for space and domestic hot water heating. The houses were designed to be super insulated and therefore only use about one tenth of the heating energy in comparison to a conventional house at the time or approximately '*10kWh per day'* (HHP, 2002) .Heat pumps were used to provide the hot water which was stored in thermal stores, and due to the low levels of air-permeability, MVHR was employed. Double and triple- glazed windows were used as appropriate for different parts of the houses.

The Hockerton houses were designed to have internal temperatures ranging between 19-21˚C throughout the year. The internal temperatures were however found to vary between the different houses due to different occupancy levels. On average they were found to maintain indoor air temperatures at 18-20˚C. Monitoring of overall energy levels has shown these to roughly comply with predictions but with some homes using considerably more energy than anticipated, this has particularly been the case in homes with

> '*teenage children in residence'*. (HHP, 2002)

Once the children had left home a marked reduction in energy use was noted.

The Zero-Heating House, Peterculter, Aberdeen, Scotland

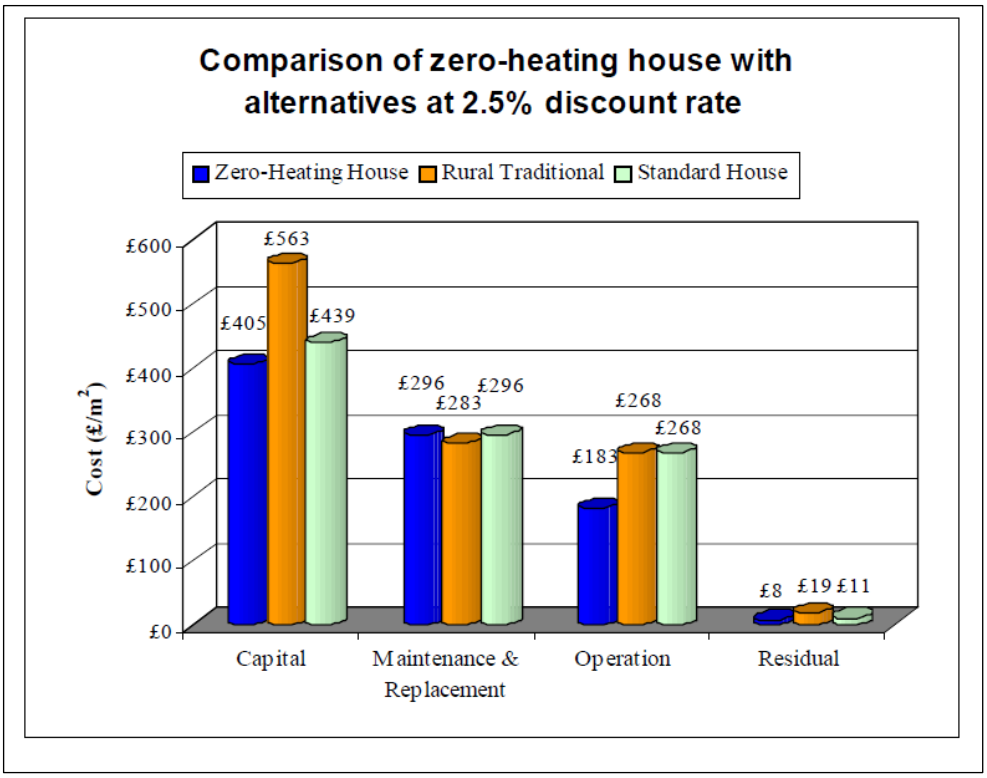
The four bedroom, Zero-Heating House, Peterculter, Aberdeen, Scotland was built in 2000 by Chartered Architect, Gokay Deveci. This house was constructed on a semi-urban site surrounded by more 'conventional' homes. The client's aim for this project was to construct a future-proof, low energy family home, but at an affordable price.

This house was built using a super insulated fabric, triple low-e glazing, mechanical ventilation with heat recovery and sustainable locally resourced materials. While the house was designed not to use heating, a 'back-up' wood burning stove system was also provided.

This dwelling was constructed using a timber 'I' beam system which was quick to build and which allowed for a large depth of insulation. This was then clad in '*locally sourced larch cladding and clay pantiles*'(IEA, n.d.)

When comparisons were made between the capital cost, maintenance, operational costs and residual costs, the Zero-Heating House was found to be cheaper than a standard house and a traditional rural house in all respects except for the maintenance costs which were found to be the same as those for a standard house.

When monitored the Zero-Heating House was found to perform largely as anticipated by reducing the need for space heating by 80% of conventional requirements for a standard house at the time . (IEA, n.d.)



(IEA, n.d.)

Figure 7 - Comparison of Peterculter Zero-Heating House with alternative dwellings

BEDZED

Post the development of the all the projects described above, a significant development of low energy housing was constructed in Sutton south London by the Bioregional Development group with the Peabody Housing Association and Bill Dunster Architects.

BEDZED or the Beddington Zero (Fossil) Energy Development is a mixed-use scheme of 82 homes and 2,500m^2 of commercial space. It was completed and occupied in 2002. The aim of the scheme was to enable its residents to live a more sustainable and energy efficient lifestyle, thus the design of the project encompasses measures which range from on-site renewable energy technologies to a car-share scheme.

The project was designed to reduce the need for space heating via increasing insulation levels of the fabric while employing passive solar design principles. The air-tightness parameters for the housing and offices was also designed to be much higher than more conventional housing at 2 ach @ 50 Pa as opposed to the current building regulations 10 ach @ 50 Pa. The housing also uses specially designed natural ventilation wind cowls that employ heat recovery mechanisms. These were installed on the roofs of this development to support the more conventional natural ventilation strategy that was achieved through opening and closing windows.

The internal temperatures were designed to be not less than 17˚C so that –

> *'during periods of in-occupancy, a back-up trickle heat source is activated if temperatures fall below 18˚C.'* (Lazaraus and Bioregional Development Group, 2004)

The performance of BEDZED was monitored and it was found that the wind cowls did not perform as anticipated and that over-heating became a problem during the hottest days in summer for some of the dwellings. In conjunction to this the biomass CHP (combined heat and power) on-site renewable energy system that was designed to provide power for the development and heating for domestic hot water and top-up space heating failed to work as anticipated, leaving residents without hot water during some winter months. Despite initial

teething problems the development was and still is considered exemplar and is popular with residents.

Passivhaus in the UK

On 17th January 1997, Dr. Robert Lowe from Leeds Metropolitan University made a proposal to participate in the CEPHEUS (Cost Efficient Passive Houses as European Standards) programme with the intention of building 10 UK dwellings, 6 of which were to be semi-detached houses, built to the Passivhaus standard, in the village of Leonminster, UK. Unfortunately, this proposal, which was funding dependent, did not receive the necessary UK support to proceed.

The CEPHEUS programme progressed in the other five European countries that formed part of the proposal, resulting in the construction of 229 dwellings built to the Passivhaus standard. These dwellings were monitored to provide performance feedback to support the development of the PHPP (Passivhaus Planning Package) design software and the eventual development of the Passivhaus standard.

Had the UK CEPHEUS programme commenced, the first Passivhaus buildings in the UK would have been completed by 1998/9 with energy and Post Occupancy Evaluation (POE) performance results being presented at the EXPO 2000 World Fair in Hannover in Germany.

In 2005 BRE (formerly the Government Institute the Building Research Establishment which was fully privatised in 1997) became a representative of the Passivhaus standard in the UK. According to a representative of BRE Wales who was interviewed in 2011 –

> *'BRE actually set up Passivhaus about four years ago so we were probably the first organisation to bring Passivhaus to the UK and it actually came from a chance meeting from a couple of colleagues from BRE in Watford who were over in Germany and basically came across it and showed a level of interest so they therefore bought the concept over here and it has kind of grown ever since then'* (Lynch, 2011a)

It was not until the spring of 2009 that the UK saw the completion of its first accredited Passivhaus dwellings and an office building, the Canolfan Hyddgen (Community Centre) in

Machynlleth, Wales. This was twelve years after the CEPHEUS programme. This development is documented as a case study as part of this research.

The Code for Sustainable Homes and the Zero Carbon Hub (ZCH)

With the launch of the European Commission Directive 2002/91/EC in 2002 which is known in the UK as The Energy Performance of Buildings Directive (EPBD), the UK government set out strategies to improve the UK Building Regulations that relate to the energy performance of buildings, specifically Part L – *The Conservation of Fuel* and Power and Part F (Means of Ventilation). Revisions to Part L of the Building Regulations were implemented in 2002, 2006 and most recently in 2010 and 2013. Further iterations are intended for 2016. The aim of these progressive revisions to Part L in the UK has been to lead the UK construction industry towards the eventual delivery of '*zero carbon'* buildings.

In conjunction to the Building Regulation revisions, the UK government together with BRE introduced revisions to the BREEAM (Building Research Establishment Environmental Assessment Method) suite of environmental standards for the assessment of buildings. As part of this suite of assessment tools, the Code for Sustainable Homes (CSH) was launched on 13th December 2006 (CLG, 2006).

The CSH was finally introduced as an operational standard in England and Wales in April 2007. The CSH standard has six levels of achievement with level six being the highest or *'zero carbon*' level. To coincide with the launch of the CSH, the government announced targets that all new housing built in England should be *'zero carbon*' by 2016, with all new non-domestic buildings should to be built to '*zero carbon'* standards by 2019 (CLG, 2007)

In the European and the global context the CSH exists as one of a palette of many different design standards for low energy building design. Within these parameters, the Passivhaus standard, which can be applied to both domestic and non-domestic buildings and to refurbishment projects is currently seen by many as the world's leading low energy design standard.

The UK's CSH, as its name suggests is only applicable to housing and currently, at the time of this research, using 2010 reguglations, only new-build and not refurbishment projects. If the CSH and Passivhaus standards are directly compared, research undertaken by the AECB,

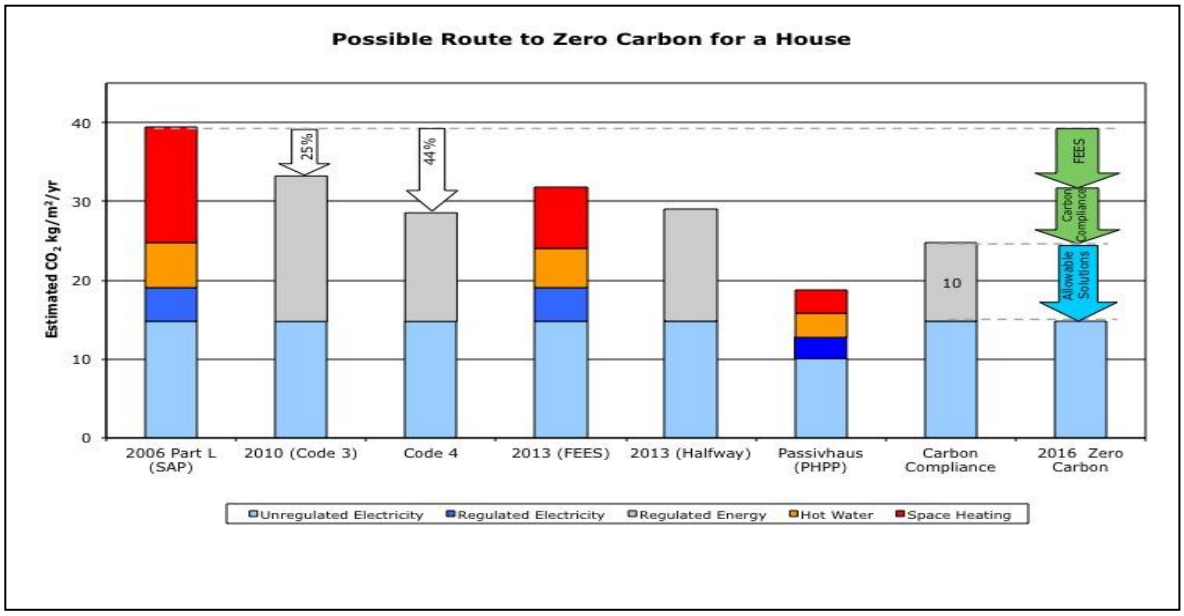
(one of at least four current organisations inclusive of BRE who represent the Passivhaus standard in the UK), suggests that Passivhaus relates roughly to CSH Level 4/5 in terms of energy performance or a 44% reduction in CO_2 emissions against the requirements of the UK Building Regulations Part L 2006 (AECB, 2008). Taking this into consideration, it may appear that the Passivhaus standard does not theoretically extend as far as UK government ambitions for absolute 'zero carbon' designs as outlined in the report '*Building a Greener Future and the Code for Sustainable Homes (CSH)*'(CLG, 2007) There are however significant differences between the CSH and the Passivhaus standard which have been highlighted by the UK Passivhaus Trust.

To examine this issue further, the Passivhaus Trust produced analysis to compare a building built to the Passivhaus standard with UK Building Regulations Part L 2010. This is documented in their report '*Passivhaus and Carbon Compliance'* April 2011 (Passivhaus Trust, 2011).

In this report it is argued that as the UK Building Regulations move progressively towards the 2016 '*zero carbon'* target, then the energy performance requirements of the Passivhaus standard present a more convincing approach to achieving this target than the adoption of the UK Building Regulations combined with the highest levels of the CSH as is intended in the UK. This is demonstrated in the extract from the report below, which outlines some of the complex measurement criteria used to achieve UK building regulations Part L and the difficulty of comparing Part L with the Passivhaus standard –

> '*It is not easy to directly compare Passivhaus with the DER/TER method of Part L. Firstly, Part L is essentially carbon-based, whereas Passivhaus is an energy standard. Moreover, Part L is concerned with regulated emissions (those due to heating, hot water, fixed lighting and ventilation) whereas Passivhaus includes targets for both heating demand and primary energy (including household appliances)...*
>
> *Part L 2010 sets a target emissions rate TER equivalent to 25% of Part L 2006. According to our estimates, after adjusting for technical differences and using appropriate assumptions as discussed above, the Passivhaus standard can deliver savings of 23-47% in regulated carbon emissions over 2006'* (Passivhaus Trust, 2011)

Figure 8 - Comparison between Passivhaus and CSH Homes



(Passivhaus Trust, 2011)

The above analysis from the Passivhaus Trust is conducted using both SAP (The Standard Assessment Procedure) and PHPP to design 'model' Passivhaus buildings. It should be noted that comparisons between the SAP and PHPP softwares conducted by both the ZCH and the AECB conclude that SAP is currently not sensitive enough to model a dwelling designed to the Passivhaus standard, or arguably 'zero carbon' parameters. (Passivhaus Trust, 2011)

The CSH design criteria also differ from Passivhaus design in a number of ways inclusive of the fact that overall performance is measured in terms of CO_2 or carbon as opposed to energy in kWh, there has been a specific requirement for on-site renewable energy technologies for higher levels of the Code, and there are also requirements for additional sustainability measures such as water conservation and sustainable materials to be used as part of the build.

The realism of attaining CSH Level 5 and the Government 2016 'zero carbon' Level 6 target for all UK housing has however been in question for a number of reasons and has recently been examined as part of a government review by the Zero Carbon Hub. Of note is the applicability of on-site renewable energy technologies to all types of locations and environments, especially built- up urban areas. In conjunction with this, arguments exist to

show that some on-site micro-renewable energy technologies are neither cost effective or the most efficient method for energy generation in either the individual or the national context. The recent Encraft and Warwick University report '*Microwind: A Catalyst for Change in UK Energy Culture*' (Encraft et al., 2009) about micro-wind generation demonstrates this point in relation to on-site wind generation and questions have been raised in relation to how cost-effective PV installations are for individual domestic sites.

Taking the above into consideration, the Passivhaus standard could be considered an effective and reliable way to approach '*zero carbon'* building design since it sets out base parameters for a highly efficient and holistic fabric design which, if implemented correctly, provides significant space heating and cooling reductions of around 80% (PHI and iPHA, n.d.)in comparison to current existing housing. In conjunction with this the Passivhaus standard sets out specific annual heating and/or cooling energy use and primary energy use targets as peak design loads in kWh/m^2. This unit of measurement is well understood and currently used by the construction and building design industry as the standard for the measurement of energy use in buildings, as is the concept of designing to peak energy loads. The metric of CO_2 or carbon was first introduced in the UK to understand building performance with the introduction of Part L in 2006 which was a revision of Part L 2002, as a UK response to the requirements of the EPBD.

Some research is also beginning to demonstrate that PHPP may offer a more reliable method for the delivery of low energy and reduced thermal bridge buildings. According to John Trinick in his paper '*Passivhaus vs. the UK approach – a non-technical comparison'* (Trinick, n.d.) PHPP is better able to facilitate the design of low energy homes than SAP because it compares a building's energy use to a fixed rather than a notional target as used in SAP and with this it rewards good initial design of efficient the shape of a building. Trinick also considers that PHPP better enables the design of thermal bridge free buildings since –

> *' PHPP, the Passivhaus model, is based on external measurements of the building, these being inherently larger, build in a margin into the standard calculation of heat loss. This has the effect of eliminating some of the academic thermal bridges present in SAP such as normal wall corners – which are really just created by geometric oddity rather than poor construction. The result with Passivhaus is that the architect*

can produce a 'thermally bridge free' design and no consultant ever needs to do a calculation. Thermally bridge free designs can be verified by simple inspection of junctions, using a rule of thumb' (Trinick, n.d.)

Since the development of the Passivhaus standard after the CEPHEUS trials, it has been adopted by many cities and regions in mainland Europe inclusive of the city of Frankfurt (Laible, 2010a). On 16 November 2009, the EU Parliament and EU Commission who instigated the EPBD, for the first time defined the intention for the development of a Europe-wide standard for 'zero-energy' buildings which would take into consideration the Passivhaus standard.

While the Passivhaus standard has evolved through the CEPHEUS programme with a database of information gathered from the metering and monitoring of the original 229 houses, the CSH was introduced without similar testing in the UK. While various CSH homes have and are being monitored privately, a consistent programme for evaluation of the standard through metering and monitoring is currently in development. This is after the launch of the standard. It could be argued that the CSH was introduced as part of a 'knee-jerk' political impetus to help the UK meet the requirements of the EPBD.

Since the development of the first Passivhaus designs in the UK, and the introduction of the CSH, industry understanding of both the Passivhaus standard and the skills required to design and build low energy buildings has been growing. The rapid introduction of recent new legislation and assessment tools and the appearance and rise of non-indigenous standards such as Passivhaus alongside the CSH have however led to some degree of confusion, firstly as to the precise definition of the new '*zero carbon'* targets and secondly as to the best ways that Part L and the CSH requirements can actually be met.

After '*The Calcutt Review of Housebuilding Delivery*' (Calcutt, 2007) identified the need for an independent body to help manage the process for the delivery of '*zero carbon'* buildings in the UK, the Zero Carbon Hub (ZCH) was established with the remit to try and promote Construction industry change and clarify Government targets. The ZCH is a 'Quango' or private-public partnership formed from a body of industry stakeholders with specific knowledge about low energy housing design, but also linked directly to the UK Government.

Through the processes of consultation and research, this organisation has been working with the construction industry to try and define and refine the Government 2016 and 2019 '*zero carbon'* targets and present a final definition for '*zero carbon'*. This research culminated in the production of the report '*Carbon Compliance – Setting an Appropriate Limit for Zero Carbon New Homes, Findings and Recommendations'* (ZCH, 2011a)in February 2011. This report concluded that the original UK government target for 'zero carbon' homes should be defined according to parameters for Carbon Compliance in kg CO_2/m^2 a. inclusive of the use of either on-site renewable technologies or '*Allowable Solutions'. '*Allowable Solutions*'* is the term used in the report to describe

> *'Forms of carbon abatement delivered off-site which mitigate any residual carbon emissions from a building once onsite requirements have been met. Specific details have not yet been announced'* (ZCH, 2011a)

In the report, 'Carbon Compliance' is dependent upon the type of dwelling with dwelling sizes based on a notional detached property of $118m^2$, attached property of 76 m^2 and a low rise apartment of 66 m^2 as follows –

- *'10 kg CO_2 (eq)/m^2/year for detatched houses'*
- *'11 kg CO_2 (eq)/m^2/year for attached houses'*
- *'14 kg CO_2 (eq)/m^2 year for low rise apartment blocks (four storeys and below)'*(ZCH, 2011a)

With the acknowledgement that –

> *'We note that over the years following 2016 the carbon emission factors for gas and grid electricity are likely to change and, at some point, the relative attractiveness of gas and electrical options (in terms of Carbon Compliance) may reverse. These effects are too speculative to steer our recommendations for 2016, but they are worth noting as they may feature strongly when regulations are revised in 2019.'*(ZCH, 2011a)

Following the release of this report in February 2011 a further report was released by the Zero Carbon Hub in July 2011 with the aim of providing some definitions for '*Allowable*

Solutions'(ZCH, 2011b). In the executive summary of this report, '*Allowable Solutions'* are described as follows –

> *'Allowable Solutions are a new concept. The developer will make a payment to an Allowable Solutions provider, who will take the responsibility and liability for ensuring that Allowable Solutions, which may be small, medium or large scale carbon-saving projects, deliver the required emissions reductions. Allowable Solutions are central to the overall policy of ensuring zero carbon is affordable, hence per unit of carbon saved, they must (initially at least) be cheaper than Carbon Compliance measures. However it is also recognised that the right framework for Allowable Solutions provides a platform for wider engagement with business and community, and presents opportunities for strong connections with both sustainability and localism.'* (ZCH, 2011b)

In conjunction to the remit of defining 'zero carbon' the Zero Carbon Hub have also been involved in discussions to revise the UK Building Regulations Part L – *The Consumption of Fuel and Power* and Part F – *Ventilation*, and have supported the production of guidance for designers to help them achieve the requirements of these regulations.

BRE Innovation Park

To support the launch of the CSH, BRE started to develop their Innovation Park at Watford, located geographically very close to Milton Keynes, the site of many early super insulated homes. This park contains five test houses designed to meet various levels of the CSH up to Level 6, the CSH highest level. BRE credit the Innovation Park as being the location for the first net-zero carbon home, the Kingspan house which reached CSH Level 6 or the CSH '*zero carbon'* level in design.

All of the housing at the Innovation Park was developed in conjunction with key UK house builders such as Barratt and Stewart Milne. The Barratt house on this site is accredited by BRE as being the first -

> *'zero carbon, CSH Level 6 home to be built by a major housebuilder'* (Barratt, n.d.)

None of the houses on this site are inhabited but all have and are being tested to various different degrees of performance inclusive of their energy use. Many lessons have been learnt from this housing particularly in relation to main-stream construction industry design and production skills and understanding. For example, the Kingspan project *The Lighthouse* which was designed by architects Sheppard Robson in conjunction with engineers Arup, cost over £1m and was developed to meet the requirements of CSH Level 5-6. Despite being 'Highly Commended' in the 2007 Green Construction awards and winner of the 'Energy Efficient Project of the Year' 2007 in the Builder and Engineer Awards, it did not achieve the air-tightness parameters that would be needed to meet the Passivhaus standard or initially meet all the CSH design requirements (Olcayto, 2007).

The Sigma House which was built at the BRE Innovation Park by contractors Stewart Milne was the first house in the UK designed to CSH Level 5, or the near 'zero carbon' level, as such and in similarity to the Lighthouse it included for micro renewable generation technologies as part of its design, for example micro scale wind turbines. The Sigma House was tested and monitored by Oxford Brookes University with research being led by Dr. Fionn Stevenson. Unlike the *Lighthouse*, this dwelling was partly occupied for the duration of the monitoring by a family of four who lived in the house for two weeks of every season of the year. Conclusions from the testing of this house included that micro renewable generation technologies such as micro wind should be avoided since they are prone to fail – as described by Stewart Dalgarno from the contractors Stewart Milne in a presentation using the findings from Oxford Brookes University and the term 'bling' to describe the micro renewables -

> *'Avoid the eco-bling – it fails'* (Dalgarno, n.d.)

It was also concluded that too many contractors and lack of integrated site management led to a sub-optimal delivery of the project and that it was important that any control systems installed for the house as a whole and for the control of thermal comfort and renewable energy technologies should be easy to use by occupants -

> '*importance of an easy to use, easy to understand user manual'* (Dalgarno, n.d.) for the house.

The results of these recent tests of the housing built to high levels of the CSH at the Innovation Park and elsewhere in the UK has started to reveal potential problems with the CSH as a vehicle for achieving '*zero carbon'* homes, but also for the potential for current UK design and construction skills to meet the government '*zero carbon'* targets or the more stringent fabric performance criteria needed for the Passivhaus standard.

> *'All those building on the BRE Innovation Park recognised the need to address skills shortages in the industry. Design, site supervision and sales will all need to develop new skills to deliver these energy-efficient dwellings to end users'* (Gaze et al., 2008)

Further recent case studies produced by the UK Government department – The Department for Communities and Local Government (CLG) have shown that other housing developed to meet the CSH Level 3 and above has been shown not to perform entirely as designed, mostly due to quality of construction but also the design and installation of building services and the performance of on-site renewable energy technologies such as biomass heating as demonstrated in the review of the Mid-Street development document in the DCLG publication '*The Code for Sustainable Homes – Case Studies'* from 2009.

> *'Generally the occupants have been satisfied with the development, but they have experienced some irritation with the erratic working of the biomass boiler system'* (DCLG, 2009)

Further examination of three CSH Level 5 homes, which should theoretically meet similar fabric design performance criteria to the Passivhaus standard, documented in the above report, show that while they meet near Passivhaus fabric insulation levels, they do not meet Passivhaus air-permeability requirements and only two out of the three use MVHR, which is used as part of Passivhaus design. The energy performance of these dwellings is still to be, or is currently being, tested.

The table below compares the performance of three recent UK developments designed to CSH 5 and documented by the DCLG. While all the developments achieve a design rating of CSH 5, all have quite variable air-permeability parameters.

Figure 9 - Comparison table between CSH Level 5 homes

Code for Sustainable Homes (CSH) Level 5 Case Studies			
Project Title	***The Old Apple Store, Stawell, Somerset***	***C02 Zero, Bristol***	***Mid-street, South Nuffield, Surrey***
Development Type	Private housing, 5 units, detached and terraced residencies	9 x two-bedroom, three storey live-work units	2 x two-bedroom flats
Construction Type	Glulam frame with Orientated Strand Board (OSB)	Solid cross-laminated timber panels with external insulation and render. Aluminium sheet roof with upstand seam and curved profile	Structural Insulated Panel System (SIPS) and beam and block flooring with mineral wool and expanded polystyrene insulation
Key Sustainability Features	Photovoltaic cells, solar thermal water heating, wood pellet boilers, rainwater harvesting	Photovoltaic cells, biomass pellet boiler, MVHR, green roof, rainwater harvesting, low flow rate sanitary ware	Photovoltaic cells, biomass pellet boiler, MVHR, rainwater harvesting, low flow rate sanitary ware
External Fabric Performance	U-value 0.14 W/m^2 K	U-value 0.10 W/m^2 K	U-value 0.14 W/m^2 K
Roof Performance	U-value 0.12 W/m^2 K	U-value 0.10 W/m^2 K	U-value 0.13 W/m^2 K
Floor Performance	U-value 0.15 W/m^2 K	U-value 0.10 W/m^2 K	U-value 0.14 W/m^2 K
Doors and Windows	External doors – U-value 1.1 W/m^2 K Triple glazed windows U-value 1.2W/m^2 K	Roof lights – U-value 1.1 W/m^2 K External doors – U-value 1.4 W/m^2 K Triple glazed windows – U-value 0.7 W/m^2 K Shop front windows – U-value 1.2 W/m^2 K	External doors – U-values 1.2 W/m^2 K Triple glazed windows U-value 0.8W/m^2 K
Air-permeability	2.17–2.57 m^3/h @ 50 pa	1.2 m^3/h @ 50 pa	4.9 m^3/h @ 50 pa

(Lynch, 2010)

CarbonLite and the AECB

In 2005 the AECB was awarded £140,000 by the Carbon Trust as part of their Networks Programme with part of this money being matched by the AECB and used to develop the '*Carbonlite*' programme and standards (Reason, 2012).The Carbonlite standards are a set of three standards for the design of low energy buildings which use the principles of the Passivhaus standard at their core. The standards are described on the Carbonlite website as being at the heart of the Carbonlite programme -

> *'A 3-stage set of realistic and workable energy performance standards lies at the heart of the CarbonLite Programme. Applicable to both residential and non-residential buildings, these performance standards act as clear and achievable targets designed to help guide all those involved in the delivery and use of energy-efficient, low-carbon new-build properties.'* (AECB, n.d.)

The three standards are the silver standard which has overall energy performance targets similar to those for Passivhaus, the actual Passivhaus standard which is the application of the Passivhaus design standard to the UK and the final and highest standard which is the Gold standard that uses Passivhaus as its base and has an additional requirement for energy-efficient electrical appliances, and demands a greater emphasis on electricity-producing renewables to offset power used for lighting, appliances and ventilation.

> *'The AECB launched its standards in July 2006 and a survey of members suggests that already well in excess of 200,000 m^2 of homes, offices and educational and community buildings designed mostly to the AECB Silver standard, but with a significant number to Gold standard, are already under development'.* (AECB, n.d.)

The Carbonlite standards are currently known to members of the AECB, which is a private organisation, but are not commonly used within the construction industry as a whole which mostly operates within the parameters of the legislative status quo – thus working towards CSH and Building Regulations compliance.

Passivhaus/Super Insulation without MVHR

Current UK building design legislation and targets are aiming at the design of low energy or '*zero carbon*' buildings. However, not all agree on the methods by which this should be achieved. There are professionals operating within the industry who believe that the use of MVHR in buildings will lead to a potential excess use in energy and poor indoor air-quality environment if MVHR is not correctly installed. This is based on previous research into the installation of MVHR in dwellings in the UK but also due to the fact that traditionally UK buildings have been constructed with high levels of infiltration or high air-permeability

which means that if MVHR is installed, it may not operate to optimum efficiency. This is described in the article '*Ventilation*' from Green Building Digest from the summer of 1999, -

> *'The Scandinavian countries have been instrumental in adding heat recovery to mechanical ventilation systems but there have been two major objections two their implementation in the UK.*
>
> *Firstly, as related to the discussion about infiltration, if the building's infiltration or 'leakiness' is so high as is normal amongst UK houses, then adding mechanical ventilation is adding ventilation that is not really needed. So the building needs to be very airtight before even considering MVHR. A pressure test value of below 3 m/h @ 50 Pa should be aimed for.*
>
> *Secondly the fan power in many MVHR units is often excessive. If mains electricity is used to power the fans, and in this country electricity is roughly 3 times as expensive and three times as polluting (in terms of CO_2 production) as fossil fuel., the addition of MVHR units to an otherwise well designed house can increase the running cost and CO_2 emissions. In one case poorly commissioned units were found where the annual fan power costs more than doubled the space heating costs'* (Warm and Woolley, 1999)

These conclusions are also supported in case studies from the book '*Solar Energy Houses: Strategies, Technologies, Examples*' from 1996 by Hestnes, Hastings and Saxhof (Hestnes et al., 1996)

Since this time the debate about the need to use MVHR in the UK climate and the assumed CO_2 emissions from fans relative to heating reduction has continued. Research conducted by the AECB and demonstrated in their paper *'Comparing Energy use and CO_2 emissions from Natural Ventilation and MVHR in a Passivhaus Home'* arues that if MVHR is correctly installed in a super-insulated and appropriately low air-permeable Passivhaus equivalent home, then it results in less CO_2 emissions from the home than from an equivalent naturally ventilated dwelling.

However, recent research undertaken in the Netherlands has shown that there can be a connection between poor indoor air-quality, poor occupant health and complaints in

relation to noise and MVHR. This is demonstrated in the research of Anke van Hal (van Hal, 2000) and Jeffry van der Pluijm (van der Pluijm, 2010). Pluijm states that –

> *'Several studies however, show a relation between a poor air quality, health concerned complaints and the presence of MVHR'* (van der Pluijm, 2010)

The conclusions of this research are however that these issues are usually connected with the poor installation and maintenance of the MVHR systems together with unfamiliarity of use of these systems for occupants.

While some reject the Passivhaus standard, the term 'Passivhaus' has been used in the UK to describe developments which are designed without the use of MVHR, for example in the case of the *Acharacle Primary School* in Lochaber in the West Highlands which was designed by Gaia Architects and completed in 2009.

This building is described as '*The UK's first Passivhaus School*' in the July edition of the CIBSE (Chartered Institute of Building Services Engineers) Journal. An article by Carina Bailey in this magazine titled '*Learning from Passive Action*', (Bailey, 2009) Howard Liddell from Gaia Architects is proud to say –

> '*basically we've cut out the mechanical ventilation system, which is unusual for passive schools because these normally have a heat-recovery ventilation system. So, in that sense, it doesn't formally comply with the German description of a Passivhaus building. That's deliberate. We feel it's quite important that the people using the building become involved in its energy conservation strategy, as opposed to it all being done by some magic box.'* (Bailey, 2009)

The First UK Passivhaus and the Passivhaus Trust

The spring of 2009 saw the completion of the first accredited Passivhaus building in the UK, the Canolfan Hyddgen (Community Centre) in Machynlleth, Wales built by JPW architects. This is documented further in the Case Studies chapter of this thesis. This building is situated in the same town in Wales as CAT (The Centre for Alternative Technology) where the early super insulated Wates Conservation House is located but built 33 years since its completion.

Post completion of the Canolfan Hyddgen, JPW architects were also responsible for delivering one of the earliest accredited Passivhaus homes in the UK, the 2-3 bedroom house 'Y Foel' which was built by private clients and is located on the outskirts of Machynlleth.

The Canolfan Hyddgen was built for the local council Powys County Council (PCC) with funding from the Welsh Assembly Government and was built to both the Passivhaus standard and BREEAM Excellent. Following the success of this project the Welsh Assembly Government launched a competition for participants to design housing to the Passivhaus standard with the competition winner being London based architects Bere Architects.

The Welsh Assembly Government also continued their support of Passivhaus projects through part financing of the development of two new homes built to the Passivhaus standard. These are situated on the regeneration site of an old steel works at Ebbw Vale in south Wales. These two homes have been designed by Bere architects. These are also documented as part of the Case Studies for this research.

In England it has largely been the role of individual protagonists, often supported by the AECB who have been responsible for the development of early Passivhaus homes and buildings. These protagonists include architect Richard Hawkes who built the highly original Passivhaus home Crossways in Kent. This house was featured on the BBC television series Grand Designs, as was the first English accredited Passivhaus home '*Underhill*', built by Helen Seymour- Smith architects. Other early Passivhaus projects have included Disability Essex, the headquarters for a charity in Essex designed by Simmonds Mills Architects and the Passivhaus at Ranulf Road in north London designed by Bere architects. In conjunction to these finished examples of Passivhaus developments there are also many other Passivhaus projects currently under construction inclusive of the Gentoo Housing Association project in Sunderland and several other developments being progressed by other housing associations in London.

Government support for the development of the Passivhaus standard in England has been more indirect than in Wales with the TSB (Technology Strategy Board) launching their Retrofit for the Future programme which is currently supporting the refurbishment of 86 homes to Passivhaus or near Passivhaus standard. The TSB is also hosting a monitoring programme called the BPE or Building Performance Evaluation programme which is currently evaluating the performance of specific low energy housing developments in the UK inclusive of some projects built to the Passivhaus standard.

Following the development in interest in the Passivhaus standard and the work of the AECB with the CarbonLite programme, the Passivhaus Trust was launched in October 2010.The Passivhaus Trust was launched as an organisation to provide support and training for those interested in building to the Passivhaus standard in the UK. According to the Passivhaus Trust (Passivhaus Trust, n.d.) as of Spring 2012 there are 24 accredited Passivhaus buildings in the UK with many more in the progress of development together with other non-accredited examples.

Summary

While the Passivhaus standard was developed in Darmstadt in Germany after the construction of the early test housing at Kranichstein followed by the trans-EU CEPHEUS programme, the early roots for this standard lie in the development of super insulated housing in the US, Canada, UK and Scandinavia over the last seventy years, but with a focus of developments from the early to mid-1970s.

In accordance with findings from the Innovation chapter of this research, this brief history starts to show how an innovation, in this case super insulated building design or the Passivhaus standard, may develop in one place or country in a linear fashion, but progress its development in a non-linear fashion towards closure across international borders or to where it gains most support in terms of culture and socio-political environment.

In the case of the super insulated building and the Passivhaus Standard, this support has been manifest in terms of commitment to research and development, political and social will and financial support that has been found in Germany. It was here where all of these

factors combined with strategic research planning and testing and feed-back which have contributed to the successful development of the Passivhaus standard. It can be argued, when examing the history chapter of this thesis, that until recent years, this type of co-ordinated strategic support for the development of super insulated homes and buildings has not been apparent in the same way in the UK.

Despite the UK producing pioneer research and examples of super insulated buildings, a lack of supportive socio-political environment has resulted in the perpetual development of individual projects and sporadic research programmes with frequently unco-ordinated results. This has not allowed for the wide dissemination of ideas to the mainstream and the development of technologies.

The introduction of the EPBD in the UK has instigated changes to the UK Building Regulations and the introduction of the CSH and UK government targets for '*zero carbon'* buildings. It has also however started to trigger an interest in the Passivhaus standard which is beginning to show signs of developing in parallel with indigenous UK building design standards despite obvious differences between the two and the complexity of the interface between these design systems.

While the Passivhaus standard has been tested for performance since 1997 resulting in a final standard with fixed performance parameters, UK standards for 'zero carbon' compliance are currently being assessed with testing carried out post the national launch of the CSH as opposed to prior to and during its evolution. This means that the cultures and supply chains to support the standard have not been able to develop in the UK, in the same way, as those surrounding the Passivhaus standard in Germany and other parts of the EU.

Key issues that seem to have been a factor in understanding the performance of the CSH buildings at the BRE Innovation Park and results from testing of CSH developments elsewhere in the UK seem to relate to construction details and air-permeability but also the design, installation and use of MVHR, on-site renewables and design and construction skills. These are similar to issues that were observed during the testing of early Passivhaus

projects which have subsequently been fed-back into the development of the Passivhaus standard.

In Germany individual commitment to develop the Passivhaus standard has worked to support the evolution of a Passivhaus culture which has grown from the Passivhaus Institut in Darmstadt and the CEPHEUS programme through to annual European Passivhaus conferences and the development of Passivhaus supply chains and a Passivhaus technology cluster as described by Rogers in his '*Diffusions of Innovations*'. This includes the development of Passivhaus certified products such as triple-glazed windows and high efficiency MVHR units, both are now exported to the UK, and all around the world. The development of this type of culture and supply chains are now starting to show embryonic signs of development in the UK, as can be seen when examining the findings from the case studies in the following chapter of this research.

Methodology

> *'History, for example, is not the telling of one limited story by one-who-knows, but by an accumulation of multiple stories, told by people themselves, and these people all share different views hopes and visions'* (Berlin, 1998)

Introduction

The Passivhaus standard is currently at the early stages of development or the innovation stage of evolution in the UK. As such it is only represented by a limited number of stakeholder individuals and buildings.

The aim of this research has been to try and gain an understanding of some of the context surrounding the early development of the Passivhaus standard in the UK. This has been conducted through review of architectural case studies and the analysis of opinions from a group of early Passivhaus innovators. At the time of this research, this group formed a large percentage of those involved with the design of Passivhaus buildings in the UK.

The importance of this research lies in the fact that it may help to establish some of the potential barriers and opportunities surrounding the current and future development of the Passivhaus standard and associated technologies within this group of stakeholders and in the UK.

This research exists within incumbent social science research paradigms predominantly surrounding qualitative research methodologies. The research methods chosen were identified as appropriate for this study because of their applicability as tools to gather data, analyse opinions and to document processes surrounding the early stage development of an innovation i.e. the Passivhaus standard in the UK. They were also deemed to be appropriate for research conducted with a small group of respondents and a small number of building developments.

The research methods were chosen to be replicable and as such should be appropriate for similar research conducted into the early stage development of other innovations.

The research employs a 'Multi-Method' or 'Mixed Methods' research approach with ethnographic processes. There is also a focus on the utilisation of the psychometric analysis

technique Q-methodology. This technique is compatible with the small scale of the group under observation together with the early stage nature of the development of the Passivhaus technology in the UK. The research methods were also chosen to be suitable for use within the time-scale and resources available surrounding this research.

Some of the limitations of this research predominantly lie in its concise nature as opposed to breadth in terms of numbers of respondents and case studies involved. These limitations could also however be seen as a 'strength' since they allow for a large quantity of information from a small group and small number of case studies to be distilled within a relatively short period of time. The results and conclusions from this research have aimed to offer a series of potential hypotheses, which also help to focus attention on further relevant study in the future.

Philosophical Perspective – Qualitative Research

> *'Not everything that counts can be counted and not everything that can be counted counts' – Attributed to Albert Einstein*

This research can be described within the context of 'Qualitative' research. It does not presume or pose an initial hypothesis to be answered as is the case with empiricist deductive processes or much 'Quantitative' research (which allows for possible relationships between variables to be identified prior to the collection of data). Instead it sits within the philosophical perspectives of the 'relativist' and 'interpretive' traditions which aim to generate hypotheses after data is captured through comparative analysis and interpretation of this data. This approach is known generically as an inductive approach to research.

The relativist and interpretive tradition primarily uses qualitative research methods to decipher meaning and contends that -

> *'the meaningfulness of the social world makes the application of scientific methods such as explanation by laws and clauses inappropriate. Instead, the social sciences should seek to grasp the meanings that individuals and social groups give to their actions and institutions'* (Seale, 2004)

The use of qualitative research in this instance is relevant because it can provide feedback in the form of current industry innovator opinion and perception surrounding Passivhaus innovation and development in the UK at the time of this research. This may potentially be of value in influencing innovator's future behaviour and/or informing wider industry or stakeholder action.

It is argued that the use of qualitative research offers the potential to look at a subject in more depth rather than breadth and to potentially expose important issues which may not be identified in larger quantitative surveys. Qualitative research also enables the examination of small groups and individuals or individual cases which are hard to study using purely quantitative research methods.

This research sits between the Weberian and Feminist research traditions. The German sociologist and political economist Max Weber (1864 –1920) believed that the study of social life should be undertaken from an empirical science basis combined with interpretation. He believed that the sole use of empirical scientific methods of research only has the capacity to tell us '*what can be done'* and not '*what should be done'* (Seale, 2004) unlike the outcome when also using interpretive methods in relation to values or opinions, as is the case with this research.

> *'The Weberian tradition is associated with the idea that values play a positive role in determining what is worth investigating'* (Seale, 2004)

He was however adamant that once a research topic and framework for analysis have been decided upon it is the responsibility of the social scientist to determine the facts in a '*value-free'* or objective manner. The Feminists and latterly the Constructivists however argued that it is not possible to conduct interpretive research that is completely devoid of the values of the researcher, and that these values should be stated and considered as part of the research process. In this case the researcher's values are stated as part of the introduction to this thesis. The researcher's values are also partly reflected in the focus groups and individual unstructured interviews undertaken as part of this research. This is evident since the researcher occasionally 'participated' in focus groups and interview dialogues in order to respond to and/or help trigger respondent opinion. The researcher

would also consider herself to be part of an emerging group of Passivhaus innovators in the UK.

In this specific case the research can also be termed inductive and '*abductive*' since it uses Q-methodology as a form of analysis. Abduction allows for similar processes as used in the inductive research but differs from induction, in that –

> *'…induction observes or studies the facts to establish a generally applicable description of the observed phenomenon. Abduction studies them in pursuit of an explanation and new insights. An attempt is being made to explain why the observed phenomenon is manifesting itself in this particular way and not others'* (Watts and Stenner, 2012)

Or as according to the scientist Charles S. Pierce, as discussed by Haig, abductive research or abduction

> '*consists of studying the facts and devising a theory to explain them'* (Haig, 2005)

For this research the Q-methodology component results in the production of a specific group of factors or hypotheses which act as a palette of ideas and provide a range of possible findings to be interpreted individually and as a whole. As such this type of research can be used to develop different strands of explanation which can be explored in isolation or combined.

According to John Bradley -

> *'Abductive methodology starts with the researcher encountering information: data...The researcher works with the data ...and produces phenomena. The researcher then develops a theory to understand phenomena.'*(Bradley, 2007)

The philosopher Thomas Kuhn (1922-1996) argued that sciences are characterised by paradigms which conceptualise the world in strikingly different ways and that conventional problem solving only exists within the disciplinary world of a particular paradigm. During a paradigm crisis competing theories gain weight and can lead to a paradigm shift which displaces the old for the new. The processes of inductive/abductive research can act as a mechanism to facilitate observation of the intervention of new ideas and the transition/s

from an old social paradigm to a new through the observation of opinions. Interpretation of these opinions may help to gain an understanding of some of the processes that may inform the basis of behaviour and societal change and the progress of innovation.

Research Design

Conducting research requires an ordered method of inquiry or research design. This should allow for transparency and future interrogation of the processes used. This should also enable research to be replicable.

Mixed Methods Research

The fluid, time-based nature of this study has led to a responsive heuristic approach to research, which employs a 'Mixed Methods' research strategy. Typically Mixed Methods research involves the use of a combination of qualitative and quantitative processes with the aim of producing more rounded final hypotheses. In this case this combination is achieved through the use of qualitative data gathering via interviews and case studies with Q-methodology used as a part-quantitative method for analysis of innovator opinions.

All of the research techniques have been chosen as being appropriate for this type of research and have the capacity to be used either individually or combined and replicated in other similar types of studies.

The process of 'triangulation' has then been used as a mechanism to seek out instances of similar phenomena occurring across research results and to support and strengthen the findings from each. This process also works as a form of validation.

The research methods employed for this research are listed below but are described individually in more detail later on in this chapter -

- Technical/Architectural Case Studies
- Focus Groups
- Q-Methodology
- Unstructured Interviews

The Case Studies document technical and architectural findings from some of the earliest Passivhaus developments in the UK and early Passivhaus developments in Germany. They

have thus been used to gain knowledge and feedback about specific issues related to the design and construction of these early Passivhaus buildings which may represent opportunities or barriers to the development of this innovation in the UK.

Given the early stage development of the Passivhaus standard/Innovation in the UK, the number of people involved in the design and construction of accredited Passivhaus buildings was very limited at the time of this research. Focus groups were chosen as a research method to gather opinion from members of this small group and as relevant within the short time period and constraints of this research. Transcriptions from the Focus Groups also provided material for the production of the concourse for the Q-methodology research.

Q-methodology was chosen as a method to help analyse the opinions from the innovator group. It was chosen specifically as an established method for sorting the opinions from small groups. Since this research involved the examination of the opinions of a small group, Q-methodology was considered an appropriate research method. More is said about Q-methodology in the following sections of this chapter.

Interviews were chosen to supplement the Q-test research and to gain further insights and opinions from those involved in the Q-tests.

All together these research methods combine as a suite of research tools which allow for opinion to be cross-referenced or triangulated against findings from each and the technical/architectural case studies.

Focus Groups

Some of the earliest recorded use of focus groups is from World War II when they played a large part in social research programmes and were used to document and understand the persuasiveness of propaganda and military training material. Since this time they have largely been used for market research e.g. to gather data about audience responses to radio and television programmes and products but also for academic research (Morgan, 1997).

After World War II, the use of focus groups experienced an initial decline which was attributed to the fact that their use was originally thought to be limited to gauging reaction to stimulus material such as films, but also because little research material about their use was actually published. More recently the use of focus groups has been systematically

developed as a research technique in the social sciences, for example in the early 1980's demographers used them to try and understand practices, attitudes and knowledge that influenced the use of contraception.

In the context of research focus groups are primarily used in three different ways –

1. As a self-contained method in which they are used in studies to provide the principle source of data.
2. As a supplementary source of data in studies that rely on some other primary data source such as that from a survey.
3. As part of a mixed-methods approach to research that combines two or more means of gathering data with no one primary method dominating; as is the case for this research

Focus groups can be of different types and constructed in various ways, ranging from very informal to more structured scenarios. They usually last about one to one and a half hours in length. Typically they are composed of homogenous/homophilious groups of subjects with about 10 to 12 participants/respondents. This size of group is chosen since it is usually more manageable within time scenarios and should technically allow for participation of all group members. Homogeneity is usually considered of importance since it has been found that people tend to be more relaxed and therefore offer more honest opinions within the context of a group that they perceive as being 'like-minded', therefore within the context of a 'safe' environment (Krueger and Casey, 2009)

Perceived weaknesses and strengths in the use of focus groups lie in the fact that they rely on the 'focus' of the researcher to provide direction. Commonly it is the aim of the researcher to provide direction without unduly influencing the opinions of participants. However, the Feminist philosophical perspective which underpins this research contends that pure objectivity is not possible in this type of research context. This is demonstrated when the researcher/focus group facilitator has on occasion offered opinion as part of the focus group so as to stimulate conversation.

The social make up of groups can work to influence feedback from respondents in either a positive or negative way, with individuals potentially either being inhibited or encouraged to

participate in dialogue. The focus group process is by nature a tool offering a 'snap-shot' of opinion and cannot ensure full participation of all respondents or reflect all opinions at all times. It can however work to gather a broad range of opinions or data within a short period of time and function well as a part of mixed methods research, especially when the results are analysed together with other research data.

Focus groups are sometimes seen as a relatively efficient way to gather data comparative to the use of individual interviews, e.g. assuming a focus group of ten people, the amount of information that can be gathered per focus group participant may be only one tenth of the amount that can be gathered in a 'one-to-one' interview over the same period of time, however the amount of different viewpoints gathered is at least tenfold. An advantage of the focus group is that it can spur additional feedback through the interaction of participants although it must be noted that some participant/s will sometimes withhold material that they would have otherwise contributed in private. (Krueger and Casey, 2009)

Q- Methodology

Q-methodology was developed by psychologist/physicist William Stephenson (1902-1989). It was introduced in a letter to the Journal '*Nature*' in 1935 and described in more detail in following papers and publications inclusive of '*Correlating Persons Instead of Tests*' published in 1935 (Stephenson, 1935) and '*Foundations of Psychometry: Four Factor Systems'* published in 1936. (Stephenson, 1936)

Q-methodology was designed as a technique for the systematic study of subjectivity, therefore the qualitative aspects of human behaviour. The technique asks a participant/s to rank a number of previously generated statements about a topic in perceived order. This is according to how much they either agree or disagree with each statement. The Q-sort or selection of statements used for sorting is typically generated from literature, via individual interviews or via the group interview or focus group. In this research it is generated through focus groups combined with literature. It is also possible to use images or other media for Q-analysis which can be sorted in the same way as statements.

An example Q-test could be devised that uses a generated set of 20 statements or Q-sort (N=20) this could be administered to a participant/subject or respondent. These statements

could be delivered in the form of a pack of numbered cards with one statement written on each. The subject would be given time to read through these and would then be initially asked to sort them into three piles representing those that they agree with, those that they disagree with and 'other' according to their own opinion, and alternative pre-ordained criteria. Finally, using a provided scale, the subject/s would be asked to rank the statements along a continuum of 'most agree' at one end to 'least agree' at the other end e.g.-

Figure 10 - Q- Matrix of Normal Distribution

Most Disagree – Most Agree

-3 -2 -1 0 +1 +2 +3

---

16 3 1 7 6 5 2

19 13 4 8 17 9 12

15 11 10 18 14

20

The above table shows numbers ordered on a matrix of normal distribution. The matrix order shows that the subject or respondent most agreed with the statements number 2 and 12 and most disagreed with statements 16 and 19 etc.

In this particular case the numbers or Q-sample distribution is 'normal', and it was the 'normal' distribution that was used for the research templates for this research. It is however entirely possible to conduct Q-analysis where the distribution of the sample set is ordered differently, since the final weighting of the 'opinions' is calculated in accordance with the number of statements against their layout position as a kind of factor analysis, with each card positioned in the matrix having in effect its own '*eigen*' or characteristic vector.

For simplicity for research respondents and to work easily with PQ software used for analysis the 'normal' distribution was used for this research.

Significantly Q-methodology differs from conventional factor analysis or the R-methodological system for factor analysis in that instead of a being a system that allows for the comparison of different measured data sets against each other, it allows for the R-methodological tradition to be inverted by -

> '*employing persons as its variables and tests, traits or other items as its sample or population'* (Watts and Stenner, 2012)

This is further described by Watts and Stenner in their book '*Doing Q-methodological Research: Theory, Method and Interpretation*'

> *'On the one hand, R methodological data is derived from a population or sample of individuals each of whom has been subjected to measurement using a collection of different tests. The new form of Q methodological data, on the other hand, is derived when a population or sample of tests (or other items) are measured or scaled relatively by a collection of individuals'* (Watts and Stenner, 2012)

It has been described by Stephenson as

> '*…a means of systematically and holistically identifying different types of people, or different types of mood, type of viewpoint and so on, across different life domains and contexts'*(Stephenson, 1953)

Initially Q-methodology was predominantly used in psychology and it is applicable to the analysis of individuals as well as groups. It has since been found appropriate for research across many sectors inclusive of the political and social sciences and more recently environmental policy development. Q-methodology has also recently been used in research relating to the development of renewable energy installations in the UK for example as part of the research methodology for the EPSRC report '*Renewable Energy and Discourses of*

Objection: Towards Deliberative Policy Making' June 2006 (Geraint et al., 2006). This report outlines the diversity of people's opinions surrounding the development of an on-shore wind farm. Q-analysis was used to assess the opinions using a concourse of 50 statements which generated 4 key factors of opinion. These were then interpreted to try and gain an understanding of the issues surrounding support for this development.
Q-methodology is of particular value in this research since it can successfully be used to assess the opinions of a very small group; this is unusual in comparison to many typical quantitative methods of analysis but has previously raised some concerns as identified below -

> *'Questions are often raised concerning the small number of cases (persons) employed in Q studies and their connection to generalizability, and part of the answer resides in the fact that Q factors are already generalizations, being 'composites' of those persons significantly loaded on them; therefore, the composite constructed to represent factor A, for example, reveals in a general way how people of that type think. (How many persons there are of a given type is another question, and one Q technique is not designed to answer* (Berry et al., 1986)

A weakness of Q-methodology is the fact that it relies on the researcher's interpretation of data but also the fact that it can only capture respondent's opinions as a 'snap-shot' from a specific moment and will reflect respondent mood at the time of undertaking the Q-test. This is however also a strength and has enabled a very immediate analysis of respondent opinion from a small group and resulting key factors of opinion this is in comparison to research methods such as content analysis which would have been more lengthy and less likely to produce such a concise analysis of opinions of this small group. Q-methodology was also used in preference to SPSS software analysis which is used to generate generate statistically significant results. However this would not have been appropriate or viable given the small number of respondents involved in this research.

Unstructured Individual Interviews

Different types of individual interviews are appropriate for different types of research depending upon the type of data to be elicited from respondents or the sample group. These range from 'Structured' interviews which employ a fixed schedule or questionnaire with each respondent being asked the same questions in the same format and in the same

order, to ‘Semi-structured’, which employ a schedule but allows deviation from the interview questions and order, to ‘Unstructured’ which employs no specific schedule but instead allows interviewee response to specific circumstances and context.

The Q-methodology research Q-tests have been supported by a series of unstructured interviews conducted with respondents undertaking the Q-tests, during the tests. These have been used to provide supporting stakeholder opinion.

The interviews conducted during the Q-tests were informal and without a schedule of questions allowing respondents to talk freely about the test or any other relevant issues to the concourse. The interviews were used as a mechanism to draw additional opinion from Q- respondents especially in relation to their decisions surrounding ordering the Q-statements or the concourse statements themselves. The unstructured interviews were also used as part of the Q-tests to help put respondents at ease during the tests but also to allow them the flexibility to ask questions or make comments about the process. The interviews were also employed as a technique to allow respondents to relax during the test process and therefore potentially offer more honest responses to the sorting.

Technical Architectural Case Studies including ‘Micro POE’ (Post Occupancy Evaluation) Case Studies

For this research the term ‘Case Study’ (Bynman, 2008)is used to describe the study of a single case or example, with the case in this research being technical architectural performance based studies relating to individual buildings.

Case Studies are often used in research to show how a particular set of interactions are imbedded in patterns of social organisation and in the case of building projects to demonstrate technical parameters, practices and performance, thus they are commonly used in the study of the built environment, architecture and engineering. According to Bent Flyvberg from Aalborg University in Denmark in his paper ‘*Five Misunderstandings about Case-Study Research’* (Flyvberg, 2006) case studies are an ideal way for a researcher to gain expert understanding of a subject area and have been used successfully in this way by those involved across different scientific research spectrums from social to natural sciences. He maintains that –

> *'Carefully chosen experiments, cases, and experiences were also critical to the development of the physics of Newton, Einstein and Bohr, just as the case study occupied a central place in the works of Darwin, Marx and Freud'* (Flyvberg, 2006)

Case Studies form a component part of the research methods for this study and are used in two ways as two sets of studies.

The first set of case studies are used to describe three early accredited Passivhaus developments in the UK and document technical construction details together with various issues that were experienced during their construction. These provide additional technical information to supplement the findings of the Q-analysis. The findings from these case studies partly support the development of the Q-concourse.

The second set of case studies describes two Passivhaus developments in Frankfurt and Berlin and documents answers to structured interviews using a set of eleven simple Post Occupancy Evaluation (POE) questions. These were employed to interview inhabitants of these developments and gain their feedback. These case studies are specifically included since at the time of this research there was very limited potential to interview inhabitants of accredited UK Passivhaus developments due to the small number of completed and occupied Passivhaus buildings at the time of this research. At the start of this research no accredited Passivhaus buildings existed in the UK and it was only during this research that all the UK case studies used for the research were completed. In conjunction to this the Larch House at Ebbw Vale (one of the case studies) was only occupied after the Q-test part of this research had already been undertaken. It was therefore not possible to conduct consistent POE interviews with residents and occupants of the UK case studies in the same way as for the German case studies. It is also important to note that POE interviews are usually best conducted after occupants have lived or worked in a building for a number of months or years so as to allow them to gain a better insight into the actual experience.

These studies were also considered of particular relevance in relation to the finding of the recent 'Sullivan' report (SBSA, 2007) referred to in the Innovation chapter of this thesis, this highlighted the need for occupants of Passivhaus buildings to learn to live with this new technology in order for it to be a success.

It was therefore considered appropriate to try and gain some feedback from residents of early Passivhaus developments and test this assumption.

Post Occupancy Evaluation (POE) is the process of evaluating the performance of a building once it has been completed. POE can be undertaken through monitoring building fabric and energy performance and through questionnaires and assessment of occupant satisfaction.

POE is defined by BRE (Building Research Establishment), who are involved in many UK POE assessments, as –

> *'… the process of obtaining feedback on a building's performance in use. The value of POE is being increasingly recognised, and it is becoming mandatory on many public projects. POE is valuable in all construction sectors, especially healthcare, education, offices, commercial and housing, where poor building performance will impact on running costs, occupant well-being and business efficiency. (BRE, n.d.)*

According to the UK based Building Services Research and Information Association (BSRIA) it is also described as being -

> *'vital for unlocking hidden information that can be valuable for informing client requirements and design briefing. POE can be used post-completion to determine whether performance meets targets.'* (BSRIA and UBT, 2009)

BSRIA outlines three main component parts of POE as follows –

- *' A forensic walkthrough; an inspection to check the building's operation and whether there are any emerging problems or wasteful operational practices*
- *An energy survey; a breakdown of the energy used in a building by type of consumption e.g. heating, air-conditioning, lighting*
- *Assessment of occupant satisfaction; surveys and interviews of building users and occupiers'* (BSRIA and UBT, 2009)

In this particular case the third bullet point relates to the type of POE assessment that was conducted with residents of Passivhaus developments in Frankfurt and Berlin. This was

carried out with consenting respondents from these two developments. In the case of the development in Frankfurt respondents were contacted via the architect of the building who asked the residents if any of them would be willing to take part in the research, after which direct contact was made with those consenting, and interview dates and times were arranged.

In the case of the Berlin development individual respondents were contacted via a resident of the building who had acted as a press officer for the development and occupant representative. Contact was then made directly with consenting respondents and dates and times for interviews established.

The number of respondents interviewed was small since available time to visit each building was only a few hours in both cases. More about this process and the respondents is included within the Case Studies section of this research.

Validation/Triangulation

Validation of qualitative research is often achieved through the method of '*triangulation*' (Seale, 2004) which refers to the technique of using more than one method of research or data gathering process, with results from all being cross-referenced. This is common within the field of the study of social phenomena such as has been the case for this research.

For this research further validation of data has also been achieved by showing focus group and interview respondents copies of transcribed text from the interviews and/or films made as part of the process. This has been to allow respondents to verify that they are happy with what they have said and allow them to consent to the use of the material as part of this research.

Ethics

Engaging with a sample group or respondents in order to gather research data requires that the researcher takes an ethical standpoint to research. The need to comply with specific ethics is usually a prerequisite of all research and may be enforced formally through established institutions such as the BSA (British Sociological Association) or self-imposed through the researcher's own principles. In this particular case it was necessary for research proposals to be approved by the UCL ethics committee prior to research being conducted. The requirements for the research were that all respondents had to be competent adults

who were willing to participate. This fact being established, the research was allowed to proceed.

The concept of ethics falls into two distinct categories the first being 'Universalism' which understands that ethical precepts are never broken. The second is 'Situation Ethics' which allows that sometimes '*the end justifies the means'* or that there is no other choice but to obscure motivations for research from respondents.

This research specifically falls within the category of universalism with respondents informed about the nature and intent of research in writing by email and/or in perso or prior to or during focus groups and interviews. Focus group and interview respondents were also asked to sign consent forms agreeing to their participation and the use of transcriptions from focus groups or interviews for the research. It was also explained to the respondents that they had the right to withdraw their input into the research at any time. A small number of the respondents withdrew permission to use transcriptions from interviews for this research

Pilot Studies

Prior to conducting research it is typical and valuable for researchers to test their methods using pilot studies. The reasons for this are to ensure the viability of the chosen methods, inclusive of applicability with-in specific time frames. Testing of equipment employed (such as voice-recorders, film equipment etc.) is also vital as is the testing of any analysis software chosen to make sure that it is appropriate and functions correctly for intended purpose.

The processes used to undertake this research were tested using pilot studies prior to research actually being conducted. These pilot studies included a test focus group, test interviews, and pilot Q-tests. More is written about the pilot studies in the following Research Methods section of this chapter.

Research Methods

The heuristic nature of this research has allowed for a degree of 'trial and error' in defining the actual processes used. The actual processes used are documented below.

Pilot Research

Pilot study tests were undertaken at the start of research to inform the overall processes. These included test interviews carried out to record dialogues with individuals and test recording equipment and transcription times, but also initial short Q-methodology tests followed by a more considered Focus Group and Q-Methodology pilot.

A preliminary pre-pilot q-analysis test was held with a group of 4 participants. The aim of this initial pilot was to assess the length of time that it would take for an individual to sort a Q-sample of statements and to test out the matrix format for assessment and the PQ software to be used for analysis. The respondents were presented with a Q-sample of 40 statements and it was found that it was possible to quickly sort these within the allotted 30 minutes.

A main pilot focus group and Q-Methodology pilot was conducted with twelve different industry professionals and stakeholders from a mixture of backgrounds relevant to the research topic. The aim of this focus group was to facilitate and record discussion which could be used to generate an initial concourse for the Q-sample to be used as part of further workshop based focus groups and Q-tests.

The people who attended this pilot focus group session were chosen from a list of about 50 relevant UK construction and consultancy industry contacts or Passivhaus innovators known to be involved in Passivhaus design and construction at the time of the research, but also according to their availability to attend. These respondents were chosen from a broad cross-section of professions ranging from architects and engineers to representatives from Government and education. The list of respondents did not encompass all possible types of consultants or contractors in the construction industry involved in Passivhaus innovation at the time of the research since the entire spectrum of professions and trades working with this innovation were not equally represented in this small community (at the time of reseach) or available to attend the focus groups. According to the UCL ethics research committee all attendees were deemed to be competent adults, so no special ethical consent was required for this pilot or the later focus groups, Q-tests or interviews.

The pilot focus group was held at UCL on 29th May 2009 between 14.30 and 16.00 and it was filmed and recorded. Originally, fourteen people were invited to attend the group with the

anticipation that some would not be able to attend on the day, this proved to be the case, leaving a final total of twelve respondents.

The aim of this initial pilot focus group was to test the research processes but also to allow participants to talk freely and provide data that would be transcribed and used to generate statements for a Q-sample set for the eventual Q-tests and Q-methodology analysis as part of a series of future focus groups. The transcription from this focus group is included within the Appendices of this document. Q- Statements from this transcription were generated after analysis of these transcriptions. More is said about this in the Analysis section of this chapter.

Some examples of transcribed text showing opinions taken from the focus group that led to the generation of Q-statements are shown for example below, in each case only the initials of the respondents taking part have been used to code their identities and keep them anonymous.

> Client DN – *'I think it is a great fault we make things too complex we have got too many boxes to fill when actually the notion of Passivhaus is relatively easy to do'*
>
> Architect SJ – *'also getting the base build right – just getting the fundamentals of the construction right and then building up on all these other things'*
>
> Architect DS – '*it's quite cultural I think, about our whole relationship to buildings'.*
>
> Client DN – *'I agree I think the most important part - it comes back to our builders and skills sets and I think there is a huge need for training and I also think there is a huge need for a media campaign'*

There were a variety of errors that were made surrounding the organisation of the first pilot focus group. Firstly the full address details for the location of the event were not included with all the original invitations, thus some time was wasted at the beginning of the session when a number of participants phoned to ask for full directions to the venue. Secondly, while a digital tape-recorder was used to record the event, one of the participants actually switched it off part of the way through the focus group so no secondary back-up recorded material was available. Despite being adequate for transcription, the sound quality of the

film recording was also poor since no additional microphone was used. No stills photographs were taken as a record and attendees were not reminded of any dietary specifics in relation to snacks provided e.g. if biscuits include nuts etc. Respondents also needed to be reminded that they were free to withdraw from the research at any period during the process. Respondents who attended this focus group were however asked if they consented to the use of the transcription as part of this research at a later date. Data from transcriptions from this focus group was used to contribute to the final research. This is because data was considered valuable, useful and of relevance to the development of the final concourse for the Q-tests, but also because this pilot was held with busy Passivhaus stakeholders (who as professionals working in different parts of the country) were difficult to re-assemble for further studies. It was also deemed unnecessary to re-configure this group for a second focus group since many who participated may not have wished to repeat the experience. The basic research method for this focus group also did not change as part of the actual research.

Focus Groups and Q-tests

After the initial pilot focus group was held at UCL on 29th May 2009 further focus groups were held at UCL on 20th November 2009 and 4th December 2009. These were also attended by a cross-section of invited industry professionals from a similar range of disciplines as included on 29th May 2009, according to availability.

These focus groups were filmed and the proceedings then transcribed. In conjunction to these two focus groups a further event that was held at Canolfan Hyddgen in Machynlleth, Wales on 27th November 2009 this event was not however recorded, but instead used as a further pilot Q-test.

With explicit consent from focus group respondents, film footage from the two early focus groups was used to produce a short film that was shown at the London 'green' building trade fair Ecobuild on 2nd March 2010 where a further discussion was held with delegates attending the film showing, this also acted as a validation for the film and focus group. This event was in turn also filmed with the proceedings being transcribed and used to support the development of a final Concourse for Q-tests later in the year. All the events with the exception of the Ecobuild event were used to pilot Q-methodology assessments and analysis with the focus group respondents.

Figure 11 - Table of Focus Group Events

	Date of Focus Group	No. Attendees	Purpose of Focus Group
1	29th May 2009	12 cross-industry Passivhaus stakeholders	• Pilot focus group • To produce transcription for concourse further and final Q-tests
2	20th November 2009	9 cross-industry Passivhaus stakeholders	• To produce transcription for concourse for final Q-tests • To undertake pilot Q-tests
3	27th November 2009	8 cross-industry Passivhaus stakeholders	• To undertake pilot Q-tests
4	4th December 2009	8 cross-industry Passivhaus stakeholders	• To produce transcription for concourse for final Q-tests • To undertake pilot Q-tests
5	2nd March 2010	11 cross-industry delegates at Ecobuild	• Validation • To produce transcription for concourse for final Q-tests

Prior to organisation of the focus groups, consent was obtained from the UCL ethics committee to ensure that this research and engagement with the public would be conducted on an ethical basis. All respondents were also asked for their consent to be filmed and informed of their rights to withdraw from research at any time. Suitable refreshments comprising tea, coffee, soft drinks and biscuits were provided for the respondents.

The respondents chosen to attend the focus groups were all responsible competent adults and selected from a broad cross-section of industry professionals either working with or with links to the Passivhaus design or the standard in the UK. The Passivhaus stakeholders were also chose according to their availability.

Respondents were invited to attend focus groups approximately two weeks in advance of each event thus maximising the potential of their ability to attend. At least eleven

respondents were invited to each group with an allowance being made for some cancellations on the day. Those invited and who eventually attended were those who agreed to provide their time outside of their normal work commitments and were thanked for their attendance.

The focus groups were planned to last about an hour and a half with approximately 35 minutes allowed for discussion followed by a short break and then the Q-tests. Respondents were informed of the time agenda prior to the events and upon arrival.

Respondents were seated around a semi-circular arrangement of tables with the host (the researcher) located facing the respondents, central to the arc of the curve.

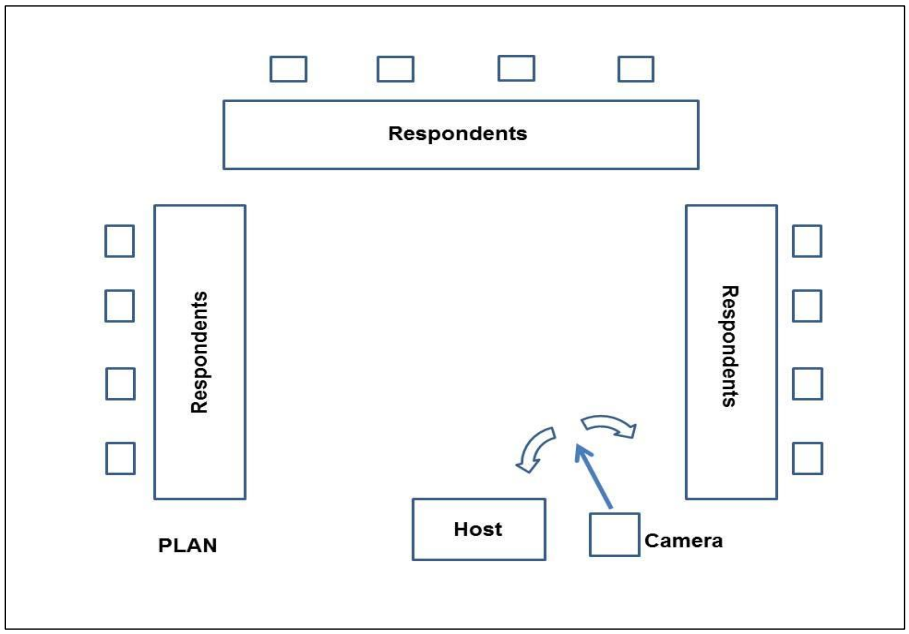


Figure 12 - Seating Diagram for Focus Groups

The respondents were also filmed from this vantage point and their conversations were recorded using digital voice recorders to supplement filming and provide back-up material in case of technical problems that may potentially be encountered during filming.

The focus group conversation was unstructured with the host (the researcher) posing the initial question – 'What are the issues surrounding the uptake of the Passivhaus Standard in the UK?' thereafter the host did not intervene in discussion unless to stop respondents talking over each other, to promote discussion during quiet moments between dialogue or to inform respondents of time constraints at the end of the session.

Q-tests

Prior to pilot Q-tests being undertaken the transcription from the pilot focus group on 29th May 2009 was analysed to help produce a Q-set of statements or concourse. More details of how this was undertaken are provided in the Analysis section of this chapter.

The pilot Q-tests that were undertaken with the respondents of the focus groups on 20th November 2009 and 4th December 2009 were conducted immediately after the actual focus group sessions with just a 15-20 minute pause as a refreshment break. The initial aim of conducting Q-tests directly after focus groups was to allow the respondents to have been inspired by the topics of discussion during the focus group prior to undertaking the Q-tests, thus helping them to think through many of the issues that were tabled when undertaking the test.

These initial Q-tests were undertaken with all the respondents seated together in the same room where the focus groups were conducted, with respondents being allowed approximately 30 minutes to undertake the test.

All respondents were provided with a Q-set or set of sample statements on paper stickers, a set of post-it notes and a paper matrix template of normal distribution. The matrix was arranged as a normal distribution to allow respondents to focus their attention on key statements of importance, i.e. those that they most strongly agreed or disagreed with. The use of a normal distribution matrix is not however essential to conducting a Q-test. The respondents were then asked that without conferring with the other respondents that they sort the statements in order of priority on the matrix. They were encouraged to stick the statements onto post-it notes prior to arranging them on the matrix so as to enable flexibility as they changed their mind through the process.

Figure 13 - Photograph of focus group respondents sorting Q-statements/set

Figure 14 - Photograph of a completed Q-matrix from the focus group above

Final Q-tests

After conducting the initial focus groups and pilot Q-tests, results from the Q-tests were analysed and interpreted. This process is documented further in the Analysis section of this chapter.

For the final Q-tests it was decided that respondents should be asked to conduct tests and be interviewed individually and in their own offices or places of work this was to avoid

respondents conferring with or being influenced by others while undertaking the Q-tests. Since the process of gathering busy working professionals together to meet on one specific day and at one time was also considered over complex and too time consuming for this procedure.

The respondents chosen to undertake the final Q-tests were picked from a range of Passivhaus stakeholders involved in a broad range of professions according to their availability. All the respondents that had been invited to the original Focus Groups were also invited to part-take in these tests but some were not available to complete them.

The original aim was to undertake analysis with up to 50 respondents from key construction industry professions represented by early Passivhaus innovators for example -

1. Architects
2. Engineers
3. Educators
4. Contractors
5. Planners
6. Clients
7. Representatives from government advisory groups
8. Etc.

The final group of Q-tests and interviews was carried out with 35 respondents who were all Passivhaus stakeholders and from the range of professions as listed above, but also including for Passivhaus/Sustainability Consultants. Unfortunately no Quantity Surveyors or Cost Consultants were available for the tests at the time of research.

It was not possible to carry out the tests and interviews with the exact proportion of respondents from each professional group due to availability of respondents within the designated Q-assessment/interview period i.e. from June- August 2010 inclusive.

Respondents that conducted the Q-tests were from the professions listed as follows –

1. Architects x 8
2. Clients x 3

3. Policy Advisors x 4
4. Educators x 3
5. Contractors x 2
6. Passivhaus/Sustainability Consultants x 4
7. Planners x 3
8. Engineers x 8

An anonymised list of all the final respondents is included within the appendices for this thesis.

These tests were conducted individually with respondents who were given a paper matrix onto which to sort the Q-sort statements. The Q-set or statements was provided on un-numbered cards, so as not to influence the respondent's ordering of the statements on the matrix. Prior to each individual Q-test, the cards were shuffled to re-order them.

Upon completion of all the Q-tests and interviews with the respondents, the tests were analysed using PQ-methodology software. PQ- software is free downloadable software specifically designed for Q-analysis. It allows a researcher to feed in the results from Q-tests which can then be analysed to sort the opinions into key different factors of opinion which are salient to the group and debate. This analysis process is presented in the following results chapter of this thesis.

Interviews

Unstructured interviews were carried out with respondents during the course of individual Q-tests. These interviews were recorded using a digital recorder and transcribed. The transcribed interviews were reviewed and used to provide supporting quotations for the final results of the Q-analysis and overall research inclusive of case studies. The transcription from all the supporting unstructured interviews is provided in the appendices.

Case Studies

This research employs five case studies. These document three of the earliest Passivhaus developments in the UK and two German Passivhaus projects. These UK case studies were chosen primarily because they are early UK examples of Passivhaus buildings, but also because they represent different design and construction processes for their delivery. The

case studies provide a cross-section of project types which are compared against each other.

The two German case studies have been included within this research as examples of multi-dwelling Passivhaus developments. Both were built allowing for occupants to be engaged in the design process from the early phases of development and are currently types of Passivhaus development not represented in the UK. They are also examples from a country where the Passivhaus standard is better developed and were developments where it was possible to interview occupants who had lived in a Passivhaus building for more than a year, and ask them about their experiences of living in these developments. This was considered particularly important since it was not possible to obtain consistent interviews from residents of UK Passivhaus developments since only one of the UK Passivhaus case studies had actually been inhabited at the time of research and another only being used as a community centre and therefore not 'lived in' by occupants.

The UK case studies are partly modelled on templates from case studies undertaken for the Good Homes Alliance (GHA) on behalf of the Department of Communities and Local Government (CLG) which resulted in the production of a booklet of four case studies documenting recent UK housing developments built to the low energy design standards of the Code for Sustainable Homes (CSH) Levels 3 and above. This booklet is publically available for purchase from the CLG and as a free download from the CLG website. (DCLG, 2009)

The Case Studies in this research have used the structural framework employed for the GHA research to inform the template employed for the UK Passivhaus projects, which followed the rough structural format as follows –

- Introduction
- Technical Performance
- Scheme Implementation
- Cost/Value
- Buyer/Occupant Feedback
- Conclusions

The use of this template also allows for ease of comparison between UK CSH low energy homes and Passivhaus dwellings which has also been undertaken in previous research by the GHA and others in the UK.

Validation

According to Lincoln and Guba (Lincoln and Guba, 1985) and Lincoln and Denzin (Lincoln and Denzin, 1994) it is necessary to establish methods by which the quality of qualitative research can be assessed, this is relevant to this research.

Lincoln and Guba propose two main criteria to enable this – trustworthiness and authenticity, where trustworthiness is made up of the following four criteria which have parallels in quantitative research –

1. **Credibility** which is paralleled with the quantitative concept of internal validity
2. **Transferability** which is paralleled with the quantitative concept of external validity
3. **Dependability** which is paralleled with reliability and
4. **Confirmability** which is paralleled with objectivity

Taking the above four points, credibility is linked to the concept of internal validity which asks for a good match between researcher's observations and the theoretical ideas that are developed out of these, therefore the conclusions of this research. Transferability is linked to the concept of external validity and refers to the degree to which any findings can be generalised across social settings. In this case across findings from other Passivhaus case studies or opinions from other Passivhaus innovators. Dependability which is paralleled with reliability is the degree to which a study can be replicated. In the case of quantitative research it is often more straightforward to replicate research than for qualitative research which instead usually requires that a researcher tries to adopt the role of the previous researcher rather than trying to exactly replicate events from a social setting, (which are clearly impossible to fix in time). Confirmability is paralleled with objectivity which refers to the how much a study relates to reality as opposed to a purely subjective response to events.

Film Validation

The medium of film has been used as part of the documentation and validation process for this research. This was chosen for pragmatic reasons to -

- Document proceedings from focus groups, thus allowing for a visual and audio recording of the events and to aid the subsequent transcription of dialogue from the focus groups.
- To document 'real-time' one-off events, for example documentation of events taking place on a construction site. This use of film supplements the case-study section of this research, but has also been used as a convenient device to show to relevant stakeholder groups in an edited form to generate discussion.
- To produce edited and reproducible documentation of focus groups that can be shown to other relevant stakeholder groups so as to generate discussion.
- To document interviews conducted in Germany with residents of Passivhaus dwellings.
- To provide edited film footage of interviews with German residents of Passivhaus dwellings for viewing by relevant stakeholders/research respondents in the UK.
- To produce edited and reproducible documentation of focus group and one-off events that can be used as an ethnographic/anthropological record of events.

Film is a method to record visual and audio data. Subsequent edited versions of film footage can be shown to research respondents as a method by which research can be validated. This allows respondents to corroborate (or otherwise) with accounts that have been arrived at. Edited film from focus groups, interviews and construction site events has been used in this way for this research.

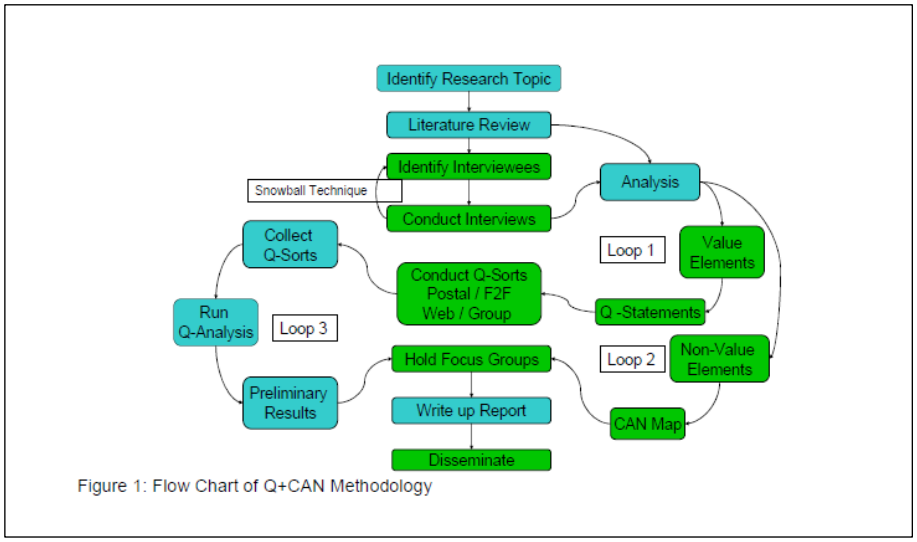
Using film is a quick and immediate way to document events and engage with an audience. Its use can however present issues relating to the confirmability or trustworthiness of research, since, sometimes through the editing process, it allows for manipulation which can distort the documentation of factual evidence. It is therefore important that a researcher keeps unedited footage and has an understanding of his or her political reference of location or reflexivity in relation to the research.

Analysis and Interpretation

The process of this research has involved several different stages of analysis. The majority of these relate to the processes surrounding Q-methodology. Different stages of analysis have been used to feed back into the entire research process and produce the whole.

In their report '*Renewable Energy and Discourses of Objection – Towards Deliberate Policy Making'* (Geraint et al., 2006)Geraint Ellis, John Barry and Clive Robinson use Q-methodology to analysis public opinion relating to on-shore wind installations. A literature review is used as part of their research processes to inform the content of early interviews which in turn produce data that is used for the production of a concourse and Q-sample for Q-methodology analysis. This process is then continued combining various 'loops' of process that feed back into the research process as a whole allowing for different stages of analysis during this process.

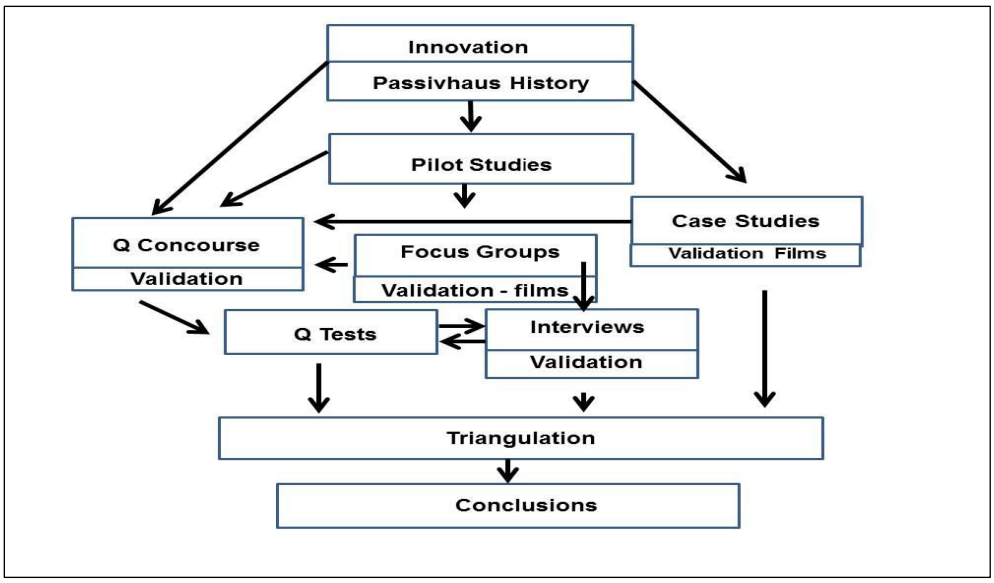
Figure 15 - Process Diagram from 'Renewable Energy and Discourses of Objection – Towards Deliberate Policy Making'



(Geraint et al., 2006)

The processes described in the flow chart diagram above allow for multiple Q-tests and focus research to loop back into the overall research process to create final results. This type of process has also been employed for this research but on a more limited and less complex scale.

Figure 16 - Research Process Diagram



Q-Methodology

Typically the process of Q-methodology is conducted in five stages as follows –

1. **The Concourse**: This is the first stage and relates to the identification of a concourse or areas of concourse that one wishes to explore. The concourse is a technical concept for the collection of as many as possible statements that people can make about a subject, taking the context of research into consideration and within the parameters of a Q-test design. 'The concourse is thus supposed to contain all the relevant aspects of all the discourses used (Brown, 1993).In the case of this research the concourse was generated from focus group/s of relevant combined industry professionals, and appropriate literature sources. It relates to the subject of potential barriers to the uptake of the Passivhaus standard in the UK.
2. **Q-sample:** The second stage is to generate a Q-sample from the concourse material. The Q-sample is a set of statements that is presented to respondents to rank in order of priority. For this research the Q-sample was generated partly using the qualitative research software Nvivo. A Q-sample can be anywhere in the region of 20 – 80 statements, but should be controlled in relation to assessment viability in terms of time etc. It is important to note that the statements forming the Q-sample do not

have to be either mutually exclusive or completely exhaustive but appropriate to cover the area of research in question.

3. **P-set:** The third stage is to select a P-set or group of respondents. The size of the P-set does not need to be large in order to generate meaningful results since Q-methodology assumes finite diversity. For this research the P-set was a group of relevant construction industry professionals and consultants who have links to or who are interested in Passivhaus construction in the UK. Many prefer the P-set to be larger than the number of statements forming the Q-sample, but this need not be the case.
4. **Q-sorting:** This is the fourth stage and refers to the process by which the respondents or P-set order the Q-sample.
5. **Analysis and Interpretation:** This is the final analytical stage of the Q-methodology process during which similarities and differences in opinions of people can be ordered and correlated using Q-factor analysis. This can be undertaken using appropriate software. In this case PQ- method software was used to produce factors for interpretation.

The Concourse and Q-sort Development

The development of a Concourse and Q-sort can take various different formats depending upon the type of research being undertaken and the priorities of those undertaking that research. Many use literature reviews or text based articles for the Concourse. For this research the basis of the Concourse has been the transcribed focus group interviews, literature review and information from the case studies

According to Watts and Stenner the exact procedure by which statements are chosen for a Q-sample can vary, with the end-product of a relevant and representative set of statements being the ultimate goal.

> *'In the end, the exact nature of the sampling task is of little consequence provided that the final Q set can justifiably claim to be 'broadly representative' of the relevant opinion domain, and this aim might clearly be satisfied in a number of different ways.'* (Watts and Stenner, 2005)

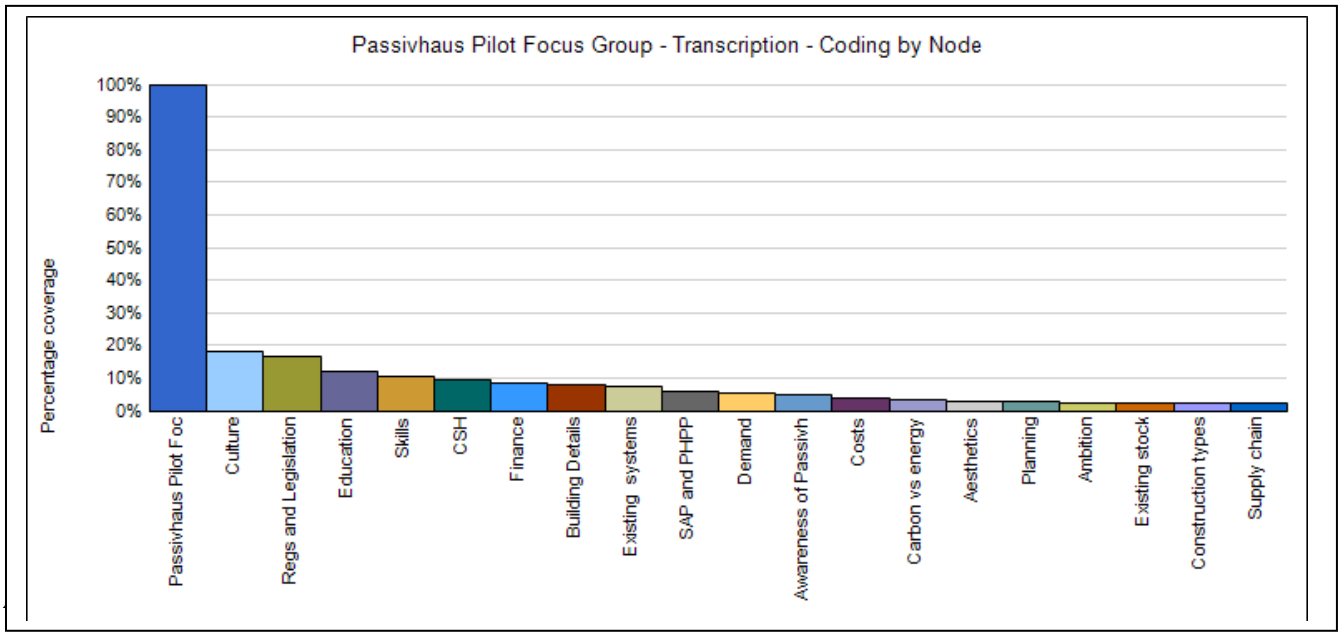
For this research transcribed texts have been analysed and coded according to prevalent themes firstly using Nvivo software then again using mind-map techniques to form the basis of the final Q-sample.

Pilot Q-tests

In the case of the first pilot group Q-tests, the Concourse used was the transcription from the Focus Group held on 29th May 2009. This was developed into a Q-sample through coding the text into specific themes with the help of Nvivo software but also including information from early the early literature reviews and the review of the history of the Passivhaus standard. The aim was to cover the broad range of themes brought up as part of focus group discussion on the theme of the barriers to the uptake of *'the Passivhaus standard in the UK*' within a concise concourse suitable for Q-tests.

Below is a sample graph generated using results from Nvivo analysis showing percentage of discussion coverage from the focus group in relation to the themes; culture, legislation, education, skills, CSH (The Code for Sustainable Homes), finance, building details, existing systems, SAP and PHPP, demand, awareness of Passivhaus, costs, carbon vs. energy, aesthetics, planning, ambition, existing stock, construction types and supply chain. These themes have been used to help develop the concourse for the pilot Q-tests.

Figure 17 - Topics of Discussion in Pilot Focus Group



These coded themes were used as guidance to produce a Q-sample of 34 statements. Some of the Q-statements relate to more than one theme, since the subjects of discussion often involved multiple issues.

Figure 18 - Pilot Q-Concourse

	Pilot Concourse – Q-sample statements	Topic Category
1	There is a lack of understanding in the UK as to what a Passivhaus actually is	Education
2	Acceptance in the UK of 'unproven' concepts	Awareness
3	General availability of component and secure supply chains within an immature market	Supply Chain
4	We lack financial incentives in the UK	Cost/finance
5	Passivhaus designs are too expensive	Cost
6	We do not understand a foreign (German language) product	Culture/Education
7	Passivhaus is not appropriate for the UK climate	Climate
8	We do not have adequate construction skills	Skills
9	We do not have adequate design skills	Skills
10	PHPP (Passivhaus Planning Package) is too complicated	SAP vs. PHPP
11	The Passivhaus standard is too inflexible	Culture/existing systems
12	We already have the Code for Sustainable Homes which is adequate	CSH
13	Passivhaus does not take overall sustainability into consideration	Existing Systems/Regulation and Legislation
14	The German name Passivhaus is not appropriate for the UK market	Culture
15	There is a lack of UK precedent	Awareness/Education
16	We do not understand building fabric performance adequately in the UK	Building Details/Education
17	Passivhaus buildings are too restrictive for occupants	Awareness/Culture
18	The materials used to construct Passivhaus designs have too high embodied energy	Awareness/Education
19	Passivhaus will not catch on unless major UK house builders design to this standard	Culture/Existing Systems/Demand
20	The UK government will only look to the BRE for advice and not beyond	Existing Systems
21	People associate low energy building design with renewables not fabric performance	Education/Carbon vs. Energy
22	UK procurement methods do not work well for Passivhaus design	Existing Systems/Culture
23	In the UK we have a 'quick-buck' mentality as opposed to one that allows for the production of quality products	Culture/Ambition
24	We are too pragmatic to adopt the standard in the UK	Culture
25	We do not adequately understand MVHR in the UK particularly in the domestic context	Education/Skills
26	UK current legislation and guidelines do not favour Passivhaus design	Regulation and Legislation
27	The Government does not understand the UK construction industry	Existing Systems
28	Our planning system is a barrier to Passivhaus design	Planning/Existing Systems
29	PHPP is not currently developed to allow for UK design scenarios	SAP vs. PHPP
30	We do not understand how to detail buildings to the Passivhaus standard in the UK	Building Details/Education

31	Current UK construction types are not appropriate for Passivhaus	Construction Types/Existing Stock
32	Current UK building aesthetics do not suit Passivhaus	Aesthetics
33	There is currently no market for Passivhaus designs in the UK	Demand
34	People in the UK are frightened by the high degree of air-tightness associated required for Passivhaus designs	Education/Awareness/Culture

The statements for this sample were chosen to cover as broad as possible range of the themes that were discussed in the Focus group but also considering the weightings from the Nvivo analysis for guidance. The number of statements was chosen to reflect the amount of time that respondents would have to carry out the Q-test or sort.

The pilot Q-tests were undertaken with a total of 29 respondents with two of the Q-sort matrices produced being spoilt. The analysis involved entering each Q-test set of statements into the software manually, calculating the significant factor loading by hand and analysis of the resulting key factors produced. This end set of data produced three key factors of opinion. The factors of opinion are groupings of opinion organised as a result of the Q-analysis which gives weightings to the opinion statements according to how the respondents have ordered them as part of the Q-tests. Therefore the opinions across the whole group are sorted into specific groups.

These factors of opinion are characterised by the following statement groupings -

Factor 1

- We lack financial incentives in the UK
- There is a lack of UK precedent
- We do not have adequate design skills
- General availability of components in a secure supply chain is a problem
- We do not think it is a problem understanding a German language product
- Passivhaus designs are not too expensive

Factor 2

- We lack financial incentives in the UK
- We do not have adequate construction skills in the UK

- We do not understand how to detail buildings to Passivhaus standard
- There is a general lack of availability of components and secure supply chain
- We do not adequately understand MVHR in the UK
- We are not worried by the German name Passivhaus
- And we do not agree that there is currently no market for Passivhaus designs in the UK

Factor 3

- We lack financial incentives in the UK
- In the UK we have a 'quick-buck' mentality as opposed to one that values quality
- There is a general lack of availability of components and secure supply chain
- UK procurement methods do not favour Passivhaus design
- We do not think that Passivhaus design buildings are too restrictive for occupants
- Nor do we think our planning system or the fact that we have the Code for Sustainable Homes are barriers to the uptake of Passivhaus design in the UK

Upon review of the findings and processes involved in this initial pilot test, flaws were discovered in the process, these related specifically to the wording of the statements making up the Q-sample which included double negatives and statements that were difficult for respondents to understand and categorise according to either positive or negative values.

Q-tests

The final Q-sample of statements for the Q-analysis was derived from the transcriptions from all the focus groups inclusive of the pilot focus group held on 29th May 2009 and the group discussion held at Ecobuild on 2nd March 2010 together with key themes from the case studies and literature review.

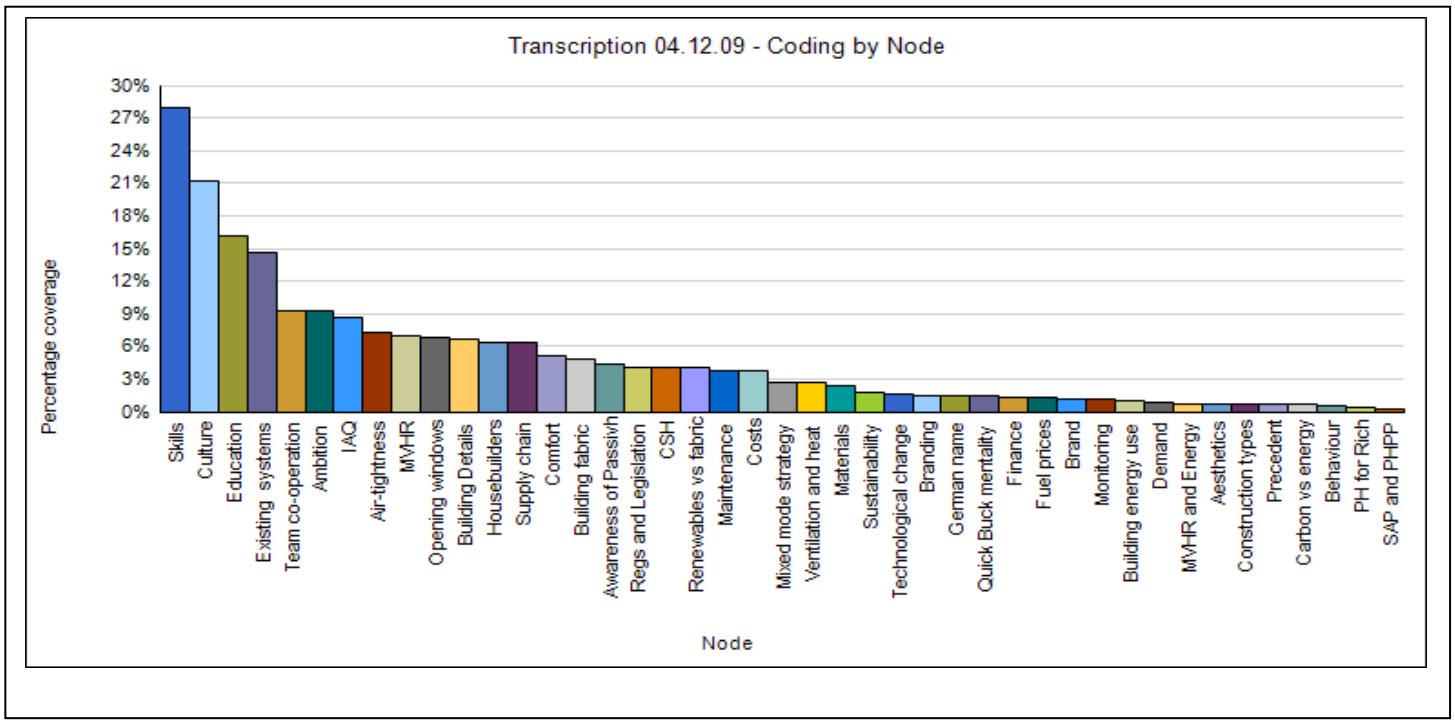
As with the Q-test pilots, Nvivo software was used as an aid to help code the transcriptions into relevant themes, relating to most discussed topics The key themes were then extracted and converted into neutral statements written in a way which could easily either be agreed or disagreed with. Once an initial set of statements was arrived at this was reviewed by a UK Passivhaus expert to see if any important areas or themes were omitted. Areas or themes

that had been found to be omitted were issues that had appeared in recent literature and press coverage relating to the development of the Passivhaus standard in the UK.

Once a significant number of statements were compiled, these were sorted into discussion themes for example those relating to legislation, or technical issues. These themed groups were then used to extract a final set of statements or Q-sample, making sure that as broad a range of issues for the sort was covered but which was also reflective of the weightings of themes of discussion as highlighted from the Nvivo coding.

The final number of statements chosen for the Q-sample was decided upon to reflect the amount of time that each respondent would have to sort the statements, which was estimated as being about 30-40 minutes. It was therefore considered that a set of approximately 40 statements would be appropriate and feasible to sort within this time-scale. The final number of statements chosen for the Q-sample was 43The graph below is a sample graph generated using Nvivo showing some potential coding of themes from the concourse but is not conclusive for the final themes used for the Q-statements forming the Q-sample. The statements for the final Q-tests often reflect more than one theme as was the case in themes discussed during focus groups.

Figure 19 - Sample graph generated using Nvivo. Discussion topics from the focus group held on 04.12.10.



The table on the following page is the final Q-sample of statements used for Q-analysis .The statements were not given to respondents as numbered statements since this may have influenced the way they chose to sort the statements on the matrix.

Figure 20 - Final Q-sample of statements used for q-analysis

	Which of the following statements which relate to the uptake of Passivhaus in the UK do you most agree or disagree with?	Topic Category
1	The Passivhaus Standard is well understood in the UK	Awareness/Education
2	Passivhaus buildings offer good comfort for occupants	Comfort
3	Passivhaus components are affordable in the UK	Supply Chain/Cost
4	There is a mature supply chain for Passivhaus components in the UK	Supply Chain
5	There are financial incentives to build Passivhaus designs in the UK	Financial incentive/cost
6	Passivhaus designs are too expensive	Cost
7	The UK responds well to the Passivhaus German Language product	Culture/Existing Systems
8	Passivhaus is appropriate for the UK climate	Climate
9	UK construction skills are appropriate to build Passivhaus designs	Skills
10	UK design skills are appropriate to design Passivhaus buildings	Skills
11	PHPP is a more appropriate software for low energy building design than SAP	SAP vs. PHPP
12	The Passivhaus standard is very flexible	Flexibility/Awareness
13	The Code for Sustainable Homes is a better standard than the Passivhaus standard	CSH/Existing Systems
14	The German name Passivhaus is appropriate for the UK market	Culture/Brand
15	The UK has many existing Passivhaus buildings to learn from	Precedent/Education
16	We understand building fabric performance well in the UK	Education
17	The materials used to construct Passivhaus designs have very high embodied energy	Education/Awareness
18	Passivhaus buildings are restrictive for occupants	Culture/Awareness
19	The Passivhaus standard will only catch on if the major house builders adopt it	Existing Systems/Culture
20	The UK Government only looks to institutions such as BRE to develop building standards	Existing Systems
21	People associate low energy building performance with on-site renewable energy technologies not fabric performance	Education
22	UK procurement methods work well to deliver Passivhaus designs	Procurement/Culture
23	The UK construction industry has a 'fast buck' mentality where quantity is more important than quality	Culture/Ambition
24	Passivhaus buildings have to perform as specified to work	Performance/Education
25	UK current legislation favours Passivhaus design	Regulation and Legislation/Existing Systems
26	MVHR uses more energy than it saves	Education/MVHR
27	Our planning system supports the Passivhaus standard well	Planning/Existing Systems
28	PHPP is developed well for UK design scenarios	SAP vs. PHPP
29	The use of MVHR improves indoor air-quality	MVHR/Indoor Air Quality/Education
30	We understand how to detail buildings well in the UK	Building Details/Skills/Education
31	UK construction types are appropriate for Passivhaus designs	Construction Type/Culture
32	There is a market for Passivhaus designs in the UK	Demand
33	Passivhaus designs work well with UK building design aesthetics	Aesthetics
34	People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	Indoor Air Quality/Education
35	The UK has a lack of ambition when it comes to building low energy buildings	Ambition/Culture
36	Passivhaus designs are future proof	Future Proof
37	Passivhaus buildings are difficult to construct	Construction/Education
38	We understand building energy performance well in the UK	Education
39	In the UK there is a good communication between construction trades	Communication/Skills/Culture
	There is good communication between different members of the design team in the UK	Communication/Skills/Culture
41	UK clients are ready to adopt the Passivhaus standard	Demand
42	The Passivhaus standard is appropriate for domestic, non-domestic buildings and refurbishment projects	Awareness/Existing Stock
43	Passivhaus needs strong and coherent representation in the UK	Representation/Awareness

Prior to undertaking the final Q-tests an initial set of statements was piloted with a key expert working within the field of Passivhaus design, this was to check that the statements were representative and relevant to the issues relating to the uptake of Passivhaus design in the UK. The statements were also reviewed by a seasoned Q-practitioner to check that they were appropriately worded to allow for the respondents to sort them.

Upon completion of all the Q-tests and interviews with the respondents, the tests were analysed using PQ-methodology software.

Research Methods Limitations

The main limitations that affect these research methods lie in the constrained time available in which to undertake the research. This has meant that the context surrounding the emergence of the Passivhaus standard in the UK and the opinions of Passivhaus protagonists may potentially have changed since the research began.

Other limitations lie in the facts that opinions of those involved in focus groups may potentially have been affected by others involved in the focus groups i.e. the social structure of the focus groups may have either inhibited or conversely encouraged respondents to contribute their opinions. This is in part compensated for through the use of more than one focus group and other literature material inclusive of findings from the case studies to produce the Q-sample. In conjunction with this people's opinions change over time and thus it is likely that if similar focus groups were conducted this year or the next, then the opinions represented would be different. This fact has the potential to act to strengthen research since the methodology can potentially be repeated at intervals to gain snap-shots of opinion over time and therefore more diverse opinion.

Specific limitations of using Q-methodology lie in the fact that this research technique involves the researcher's interpretation of data to produce a Q-set of statements and interpretation of the results of analysis. This allows the researcher's values to partly influence results. Other limitations can be linked to the fact that it produces a 'snap-shot' of opinion from a specific time as opposed to one as a temporal narrative.

The combination of the use of Q-methodology with the Case Studies allows for comparison between findings from both which allows the Q opinion analysis to be balanced against more fixed technical findings from the Case Studies.

Case Studies in themselves offer the opportunity to present a broad set of findings which some argue are by their nature case specific, they can however allow for an insight into an understanding of some more general aspects of behaviour -

> *'First we need to recognise that case studies, limited to a particular set of interactions, still allow one to examine how particular sayings and doings are embedded in particular patterns of social organisation'* (Seale, 2004)

Flyvberg (Flyvberg, 2006) however argues that case studies also allow for a deep understanding of a subject area and that generalisations can in fact be made on the basis of a single study. He also argues that -

> *'The advantage of the case study is that it can 'close in' on real-life situations and test views directly in relation to phenomena as they unfold in practice'* (Flyvberg, 2006)

As such, case studies have been used as part of this research.

Case Studies

Despite some early non-accredited Passivhaus developments being completed in the UK after 1997, notably in Scotland, it was not until January 2009 that the UK saw the completion of its first accredited Passivhaus office building, the Canolfan Hyddgen (Community Centre) in Machynlleth,Wales.

This first Passivhaus office development together with subsequent UK Passivhaus developments at 'The Works' Ebbw Vale, Wales and the Passivhaus at Denby Dale have been used as case studies to demonstrate examples of early Passivhaus buildings in the UK. They present some of the issues that were experienced through their procurement and construction and may provide further insight into factors currently affecting the uptake and the development of the Passivhaus standard in the UK.

These UK case studies have then been supplemented with similar, but occupant feedback weighted case studies, from two German Passivhaus developments in Frankfurt and Berlin. These case studies have been included to provide further information from occupants into the experiences of actually living in a Passivhaus. These case studies are also examples of multi-dwelling Passivhaus buildings, a typology that did not exist in the UK at the time of writing this thesis.

These brief occupant feedback studies from German developments also offer some insights into alternative models for Passivhaus living and procurement. This is one that allows the occupant to have a greater involvement in the design and maintenance of their buildings than is currently typical for most UK multi-dwelling developments.

With the exception of the Denby Dale Passivhaus, which was not visited during this research due to time constraints, all the case studies have been visited. Brief unstructured interviews have also been conducted with available relevant protagonists involved in their design and/or procurement. These have been use to inform the case studies. In the case of the German case studies inhabitants of the buildings have also been interviewed.

For ‘The Works’ development at Ebbw vale and the two German Passivhaus buildings, film footage was recorded of site events and interviews. This has been used as a method for data acquisition and to provide supplementary presentation material to support the case studies. This film footage together with filmed interviews with residents of the German projects are included as part of the appendices to this research.

UK Case Studies

Canolfan Hyddgen

Figure 21 - Canolfan Hyddgen, Machynlleth

Design Team

Client	Powys County Council (PCC) and Welsh Assembly Government (WAG)
Architect	John Williamson, JPW Associates
Project Management	PCC and JPW
Contractor	C.Sneade Ltd
Mechanical and Electrical (M+E) Design	JPW, Drexel and Weiss and Flare Wales Consultants
M+E Contractors	Flare Wales and EOM
BREEAM Assessor	GB Sustainable Project Management Ltd (GBSPM)

Introduction

The Canolfan Hyddgen or Community Centre in Machynlleth, Wales was designed by JPW Associates. It was commissioned by Powys County Council with funding from the Welsh Assembly Government in the Winter of 2007 as part of the Dyfi Valley Pathfinder Project (Bradley, 2009).The building finally reached completion in the spring of 2009 and has since been occupied. It is used as a community centre and for adult training inclusive of IT training.

The client's aim was to procure a low energy building that would be suitable for multi-party tenants and which would be cost efficient to run. They wanted to provide an affordable facility for the local community (PCC, 2010)

According to John Williamson, the architect for the project, the client saw the use of the Passivhaus standard as a means to comply with their intentions to provide a building with low running costs and low energy use and CO_2 emissions at the same time of achieving BREEAM Excellent.

> *'The Welsh Assembly funding brought with it the BREEAM requirements of Excellent. The client and the team aspired to exceed this standard and deliver a low carbon/energy building. To meet this requirement and aspirations, the team decided to design the building around Passivhaus principles – high levels of insulation and air-tightness, solar gain and efficient heat recovery systems to ensure low levels of energy usage, methods more commonly used in Continental Europe'* (Bradley, 2009)

Technical Performance

This building was designed to meet the dual performance targets of the UK's low energy building design standard BREEAM to the highest level of BREEAM Excellent, and the Passivhaus standard. This development was the first public sector accredited Passivhaus building in the UK and the first non-domestic building constructed in the UK that combined both BREEAM and the Passivhaus standard

> *'The building is the first public sector building in the UK to be certified by the Passivhaus Institut'* (Bradley, 2009)

The aim of using both standards was to construct a building that would have the low energy performance associated with the Passivhaus standard at the same time as employing wider sustainability criteria as specified within BREEAM, such as the incorporation of on-site renewable energy technologies and sustainable and locally sourced construction materials.

The overall energy performance target was to reduce space heating by 85%, thus also reducing overall CO_2 emissions and facilitating compliance with PCC CO_2 overall reduction targets of 30% by 2012 and 50% by 2017. It was estimated that the centre would yield potential carbon saving of 39,000 tonnes and cost savings of £7.8m between 2009 and 2014 (Williamson, 2009a)

Building Fabric

A combination of construction methods were used for this building these combined a central masonry core with external timber frame and I-beam cassette roof. Care was taken

in the design of the timber frame to ensure for thermal bridge free junction details, which are required to meet the Passivhaus standard and to allow for the incorporation of the air-tightness breathable membrane. A living roof forms part of the design for this building and a heavy- weight floor construction is used to provide thermal mass to help moderate internal temperatures. Cellulose insulation was utilised throughout the external fabric as were triple-glazed Passivhaus certified windows.

> '*External walls are constructed from prefabricated timber frame and wood-faced cassettes, which incorporate recycled newspaper insulation. The first floor is constructed from hollowcore concrete slabs. The solution adds thermal mass to the building while enabling the use of a pre-fabricated, highly insulated, lightweight façade'* (Williamson, 2011a)

Figure 22 - Canolfan Hyddgen Fabric Performance

Fabric Performance	
Element	**U-value/performance**
North pitched roof	U-value 0.11W/m^2 K
South pitched roof	U-value 0.12W/m^2 K
Walls	U-value 0.12W/m^2 K
Ground	U-value 0.12W/m^2 K
Doors and Windows	U-value 0.79W/m^2 K
Air-permeability	0.249 -1 @ 50 Pa

Building Services - Heating, Cooling, Ventilation, Lighting and Appliances

A mixed-mode ventilation strategy was employed which uses a timer and PIR (Passive Infrared) controlled ventilation system comprising five Drexel and Weiss Aerobusiness MVHR units, supplemented with a night-time cooling strategy which allows for windows to open at night to provide additional natural ventilation and cooling.

The building was designed to make maximum use of daylight to meet BREEAM requirements. Low energy daylight linked, artificial lighting using T5 linear fluorescent lamps have been installed throughout the interior. The lighting was designed within the overall energy use parameters of 10W/m^2, so as to meet the requirements of Passivhaus design.

A BEMS (Building Energy Management System) has been installed that allows for remote management of the building energy systems. Low energy computers and monitors were used throughout, but were these were not as efficient as is possible, due to procurement issues with PCC.

> *'As the project's design phase was coming to a close, Powys County Council decided to add a computer server room to the scheme. This added another 720 Watts of heat to the project. The Council also decided to stick with its existing IT supplier rather than purchase the low energy PCs originally proposed. As a result of the changes the scheme's predicted energy consumption rocketed to 184 kWh/m^2/yr, which was a long way above the 120 kWh/m^2/yr figure which would guarantee Passivhaus certification'* (Williamson, 2011a)

Despite this additional heating load, which is relatively small in comparison to the overall demand in a non-Passivhaus and more conventional similar building, the changes relating to the IT systems meant that the architects had to devise new methods by which to control this additional heat gain in the building. This was achieved by adding a brise soleil to the south façade, daylight linked controlled lighting and through fitting mechanical timers to sockets to eliminate standby losses.

> *'Finally, movement detectors were added to the MVHR units serving the computer suites to enable the room's lights to be turned off and the MVHR units to run at minimum speed when the space was unoccupied'* (Williamson, 2011a)

These changes reduced final loads down to 144 kWh/ m^2 a. Which is still technically over the compliance limit for Passivhaus certification but

> *'the Institut still certified the building because the computer servers supply other buildings and because the designers had done everything possible to reduce the loads'* (Williamson, 2011a)

Auxiliary space heating was provided using an ultra low NOX 24kW gas boiler. This was installed despite heating loads only meeting 4.8kW due to the fact that the contractor employed

> *'… had not worked on a Passivhaus scheme before'* (Williamson, 2011a)

The use of a low NOX boiler is a requirement of BREEAM compliance. The heat from this boiler is distributed using radiators with TRV (Thermostatic Radiator Valves) and thermostat zone control. Domestic hot water is provided using a localised 15-30 litre instantaneous electric water heater. Low flow taps have been installed as have waterless urinals.

A 7kW array of roof-mounted photovoltaic panels (PVs) has been installed with the intention that this is supplemented at a later date by a further 20kW array, which will be mounted remotely from the building itself. The intention of this is to provide further carbon reductions from the building so that it will meet UK targets required for a net '*zero carbon*' building.

Cost

The 410m^2 building had a base build cost of £1537 /m^2 and the overall cost including PVs, living roof and canopy was £1784 /m^2. (Williamson, 2011a)

According to cost analysis presented by BRE and Quantity Surveyors Faithful and Gould in their report dated September 2008 the benchmark cost to procure a Part L Building Regulations compliant secondary school of 3116 m^2 is estimated to be £1711/m^2 and for this building type to meet the requirements of BREEAM Excellent the cost would be between £1789-1865/ m^2 (BRE and Faithful and Gould, 2008)

The Canolfan Hyddgen can therefore be seen to have cost a similar price to an equivalent sized UK school building built only to BREEAM Excellent compliance.

Scheme Implementation

The centre is currently being monitored using a remote access monitoring system with data gathered being analysed by the Passivhaus Institute in Darmstadt (Williamson, 2009a).This is to gain a better understanding of the performance of a Passivhaus building in the UK

climate. This information is also intended to help inform the client about energy use and enable improved billing and management strategies.

Wherever possible components used for the construction of this building were UK sourced. Key components such as the MVHR systems and windows were however supplied from Germany and Austria due to lack of indigenous UK availability of suitable products at the time of construction.

According to John Williamson from JPW architects, Drexel and Weiss who were the manufacturers of the MVHR units were originally reluctant to supply their equipment for use on this project due to the fact that they did not trust British design ability and workmanship skills which they thought could possibly discredit their products (Williamson, 2012). In conjunction to this, the UK M+E engineers were not confident with supporting certain aspects of the Passivhaus design which meant that this aspect of the design had to be carried out at risk by JPW. John Williamson also stressed that the success of the project was reliant on strict adherence to quality control of construction processes on site (Williamson, 2012).

In an article from Green Building magazine titled *'First Certified non-domestic Passivhaus in the UK',* architect John Williamson spoke about some of the issues that inhibited the procurement process for the project and stated that -

> *'A major issue appears to be that councils are locked into framework agreements involving the more conventional technologies because their maintenance teams and procurement officers are reluctant or unable to change suppliers quickly'*(Williamson, 2009a)

Other challenging issues included the design and installation of suitable thermal bridge free details that the timber frame supplier could guarantee and that the Passivhaus Institute in Darmstadt would accept.

Buyer/Occupant Feedback

This project has initially been well-received by both the client and occupants and after the first two years monitoring its performance has exceeded that of the design predictions. The designed energy consumption figures were originally predicted as being 144kWh/m^2 a., but

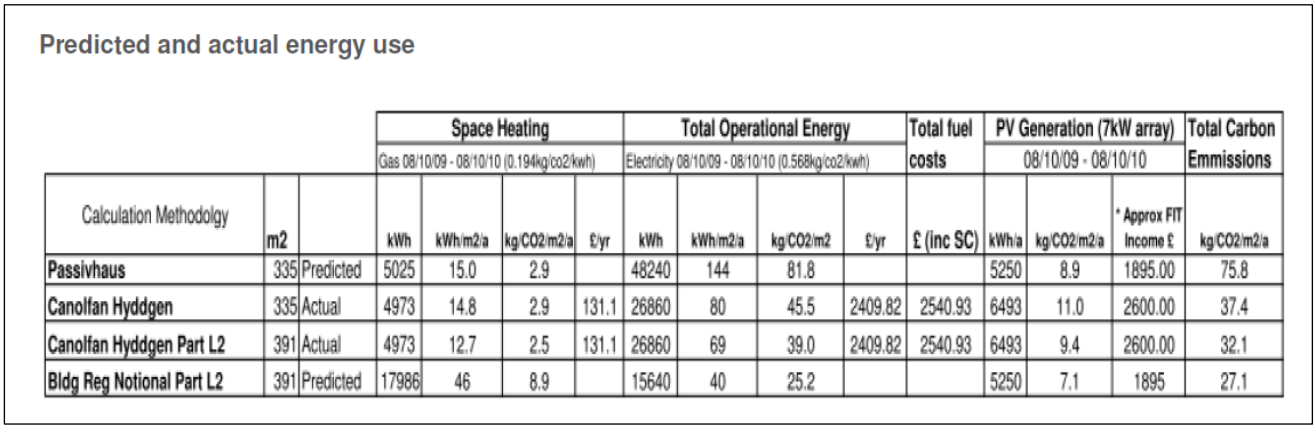
were shown to be only 80 kWh/m^2 a (Pearson, 2011).The heating loads for the building were also lower than expected being 14.8 kWh/m^2 a. as opposed to the 15kWh/m^2 a. which is the requirement to meet the Passivhaus standard. This lower energy and space heating use has led to reduced bills with annual heating costs of just £130. (Pearson, 2011)

This building was also found to perform well in terms of occupant comfort with internal winter temperatures ranging between 20°C and 22°C, depending upon occupant settings of TRVs. The results of the monitoring of the summer internal temperatures during the first year showed temperatures reaching as high as 26°C, this was however investigated and explained due to damage to an external sensor which caused a fault in the night-time purge ventilation. (Pearson, 2011)

The table below (Figure 23), shows as predicted and actual monitored energy performance for the Canolfan Hyddgen. The building was designed using PHPP which is a requirement of Passivhaus compliance. It was also modelled using TAS software so as to comply with UK Building Regulations. Modelling the building for compliance with both UK Building regulations and the Passivhaus standard created more work and costs as explained by John Williamson -

> *'However creating two sets of data for PHPP and TAS was time consuming and did add to the costs'* (Williamson, 2011b)

Figure 23 - Canolfan Hyddgen Predicted and Measured Performance



Predicted and actual energy use

			Space Heating				Total Operational Energy				Total fuel costs	PV Generation (7kW array)			Total Carbon Emmissions
			Gas 08/10/09 - 08/10/10 (0.194kg/co2/kwh)				Electricity 08/10/09 - 08/10/10 (0.568kg/co2/kwh)					08/10/09 - 08/10/10			
Calculation Methodolgy	m2		kWh	kWh/m2/a	kg/CO2/m2/a	£/yr	kWh	kWh/m2/a	kg/CO2/m2	£/yr	£ (inc SC)	kWh/a	kg/CO2/m2/a	* Approx FIT Income £	kg/CO2/m2/a
Passivhaus	335	Predicted	5025	15.0	2.9		48240	144	81.8			5250	8.9	1895.00	75.8
Canolfan Hyddgen	335	Actual	4973	14.8	2.9	131.1	26860	80	45.5	2409.82	2540.93	6493	11.0	2600.00	37.4
Canolfan Hyddgen Part L2	391	Actual	4973	12.7	2.5	131.1	26860	69	39.0	2409.82	2540.93	6493	9.4	2600.00	32.1
Bldg Reg Notional Part L2	391	Predicted	17986	46	8.9		15640	40	25.2			5250	7.1	1895	27.1

(Williamson, 2011a)

Conclusions

Some key issues that had to be addressed to enable the successful delivery of this project were –

- A special consideration to detail design
- An adherence to careful on-site quality control
- Perseverance of the design team when dealing with the design and procurement of non-UK based technical systems such as the MVHR units i.e. reassurances had to be gained and extra communications were necessary with suppliers of non-UK manufactured equipment to support performance and installation
- It was felt that this project was delivered successfully in spite of, and not because of, existing public procurement frameworks and systems.

According to the PCC Good Practice report produced as part the Excellence Wales scheme, lessons learnt from delivery of the project were –

> *'To achieve a low or zero carbon building, a collaborative working approach between the client, project manager, design team and contractor is required. The contractor must be involved at a very early stage in the design process. A lowest price or*

> *adversarial culture is counterproductive. Envelope air-tightness is the fundamental foundation of a sustainable low or zero carbon building. 'Eco bolt on' systems alone will not achieve this aspiration. The whole team, including the client must be prepared to use new construction techniques and innovative products'* (Bradley, 2009)

Although this was the first UK accredited Passivhaus building, and was built to both the Passivhaus standard and BREEAM Excellent, it was built at no extra cost in comparison to an equivalent, non-Passivhaus building in the UK. This building was also designed and constructed by UK consultants and contractors and largely using UK sourced materials, thus proving the initial potential viability of the use of the Passivhaus standard to construct this type of project in the UK.

Larch House: The Works EbbwVale

Figure 24 - The Larch House, Ebbw Vale

Photo by Mike Dearden

Design Team

Client	United Welsh Housing Association and WAG
Project Management	Bere Architects and BRE
Architect	Bere Architects
Contractor	Pendragon Design and Build Ltd
Mechanical and Electrical (M+E) Design	Alan Clarke
Structural Engineer	Bob Johnson Consulting Structural Engineers
CSH Assessor	Brooks Devlin
Air-pressure Test	ALDAS Paul Jennings

Introduction

The Larch house is one of a pair of three bedroom family houses that have been constructed to the Passivhaus standard as part of '*The Future Works Housing'* development at 'The Works' Ebbw Vale regeneration project in Wales. The client for the houses was United Welsh Housing and these dwellings are two of 720 low energy houses that are being procured by various local organisations in the Ebbw Vale area, and which are being constructed on the site of an old steelworks at Ebbw Vale, South Wales.

The housing forms part of a £300m mixed use regeneration plan which is being co-ordinated by Blaenau Gwent County Borough Council (BGCBC) and the Welsh Assembly (WAG). The design requirement for all the housing on the site is that it should be designed to a

minimum specification performance of CSH Level 5 compliance. The remit of BGCBC and WAG has been to provide affordable energy efficient housing for the future –

> *'… establishing Ebbw Vale as the centre of a new sustainable construction industry in Wales and inspire a generation of housing that sets new standards in energy efficiency while being affordable and very cheap to run* (Bleaunau Gwent County Borough Council, 2012)

Technical Performance

The Larch house has been built to the Passivhaus standard at the same time as achieving CSH Level 6 which makes it (according to Bere Architects on their blog) -

> *'The UK's first zero carbon (CSH Code 6) low cost, certified Passivhaus'* (Bere Architects, 2012)

In accordance with client requirements the house is being monitored to assess energy performance by the Welsh School of Architecture with funding from the UK Government organisation, the Technology Strategy Board (TSB). This monitoring includes a co-heating test conducted prior to it being occupied. This is being followed by energy use and POE monitoring during the first year of occupancy from 2012. Initial energy monitoring of the project commenced in February 2011.

Building Fabric

The Larch House was built using timber frame construction on a concrete raft foundation.

The home was designed to make maximum use of passive solar gains to support winter heating demand through the use of large south facing, Passivhaus certified windows. These cover 55% are of the south facade. Part of the aim of the windows is to optimise daylight levels within the house, but their size added to the final costs.

In contrast to the design of the Larch House, the second Passivhaus designed by Bere Architects for this site; 'The Lime House', uses smaller windows and the design strategy to achieve the Passivhaus standard which focuses on an overall average heat load of a maximum of $10W/m^2$. Passivhaus certified Windows meeting the requirements of the Passivhaus standard were specially designed for the Lime House and as products to be manufactured in the UK.

Figure 25 - The Larch House Fabric Performance

Fabric Performance	
Element	**U-value/ Performance**
Roof	U-value 0.074W/m^2 K
Walls	U- value 0.095 W/m^2 K
Ground	U-value 0.076W/m^2 K
Windows	U-value 0.8W/m^2 K
Air-permeability	0.2 h-1 @ 50 Pa

Building Services - Heating, Cooling, Ventilation, Lighting and Appliances

The ventilation for the Larch house is via a whole house ventilation system using a Passivhaus accredited German MVHR unit. Top-up space heating and domestic hot water heating has been supplied from a gas condensing boiler. Domestic hot water supply is also supported through the use of roof mounted solar thermal panels.
According to Peter Warm who certified the project as a Passivhaus project in the UK –

> '*On the heat load UK suffers from a lack of weather data containing heat load data. Our approach in the UK so far, has been to avoid heating just by the ventilation system, and so we have supplementary heating which has been designed to be independent. This has been sized separately to PHPP' Peter Warm* (PHI, 2012a)

Low energy lighting using compact fluorescent and LED lamps has been used throughout as have low energy appliances. Additional small power is supplied through photovoltaic panels. Specific details were provided by the design team for all service penetrations of the air-tight barrier. The number of these penetrations was kept to a minimum and any additional penetrations required during the build were specially cleared by the design team.

Cost

Cost comparisons were undertaken against the Royal Institute of Chartered Surveyors (RICS) RICS/BCIS database for one-off detached houses on lowland sites. These provided the following costs for the Larch and Lime house in comparison to standard UK estate houses.

The 100m^2 three bedroom Larch House built to CSH Level 6 and the Passivhaus standard inclusive of PV array, large windows and external sunshade blinds was priced at £1700/m^2 with a typical estate house costing £1105/m^2. The cost of the Larch Passivhaus excluding the PVs but including the large windows and external sunshade blinds was £1471/m^2 with a comparable estate house being priced at £956/m^2(Bere Architects, 2012).

The overall conclusion of the costing was that currently building to the Passivhaus standard for a mass house builder, as part of an estate project, using this type of design and construction would potentially mean an increase in the region of £9,500 more per unit or an equivalent uplift of about 10%, however additional build costs could be offset against energy in use savings from the house throughout its life-time with payback periods of approximately 14-17 years (Bere Architects, 2012)

Scheme Implementation

This was a prototype development and according to the architects great care was taken to construct the house to the design specifications. This included the provision of relevant training for the contractors when new skills were required. For example, German window manufacturers were brought over from Germany to demonstrate the processes required to install a window to the Passivhaus standard. Part of this process has been filmed to accompany these case studies and is included as part of the appendices.

Buyer/Occupant Feedback

The Larch house is currently occupied by family who took part in a competition to live there (Bere Architects, 2012).

A user guide in the form of a poster was provided by Bere architects to help inform the occupants about the operation of technologies and control strategies for the house.

Conclusions

This project highlights some key issues in relation to the development of the Passivhaus standard in the UK, for example the potential need for skills training to enable contractors to better understand the construction techniques required to build a Passivhaus building.

These houses demonstrate two different approaches to meet Passivhaus compliance which have resulted in separate designs and project costs. These designs may also result in different levels of energy performance over time especially considering the different glazed areas and window sizes for The Larch House and The Lime House. This could have the potential to affect heat gains and losses.

The estimated 10% increase in cost in comparison to similar 'conventional' estate housing could prove prohibitive to contractors and/developers and also to customers if this cost is passed on through the sale of the housing, even if energy in use costs are estimated to be very low. It is argued that these costs relate to the prototype nature of the project and it would be anticipated that they would reduce as expertise and design understanding develops.

In a similar way to the Canolfan Hyddgen project, quality assurance (QA) procedures ensuring specific care to detail design and construction were essential for the successful delivery of this project and meeting the Passivhaus low air-permeability requirements.

The Denby Dale Passivhaus

Figure 26 - Denby Dale Passivhaus

Design Team

Client	Geoff and Kate Tunstall
Architect	Derrie O'Sullivan
Project Management	Bill Butcher, Chris Herring and the Green Building Store
Contractor	The Green Building Company
Mechanical and Electrical (M+E) Design	Peter Warm and Warm Low Energy Building Practice
Mechanical and Electrical Contractors	The Green Building Company
Code for Sustainable Homes (CSH) Assessor	Jim Parker *(1st Base Projects N.B only a part CSH assessment was completed)*

Introduction

The Denby Dale Passivhaus which is located in West Yorkshire in the UK is a 118m^2 three bedroom detached house built by private clients who wanted an affordable and energy efficient home for retirement.

Geoff and Kate Tunstall who are the clients of The Denby Dale Passivhaus, employed Bill Butcher, a director of a local 'green' building supply and contracting company, the Green Building Store, as a consultant for their project. He recommended that the couple build their home to the German Passivhaus Standard.

This project is one of the first Passivhaus buildings to be completed and accredited in the UK. It is also a Passivhaus built in a typical UK vernacular style using indigenous British cavity wall construction techniques. These are techniques generally familiar to the UK construction workforce.

This project is different from the majority of Passivhaus buildings that have been constructed in mainland Europe which usually either employ timber frame construction or concrete structure with cladding and external insulation with render(Williamson, 2009b).

The cavity wall construction method was chosen for this house to prove that it is possible to build to the Passivhaus Standard using this construction technique but also to comply with local planning regulations that asked for the house to be clad in a stone finish in keeping with the aesthetics of surrounding local buildings.

The project was built with the support of the local authority from the county of Yorkshire who were keen to help promote those innovating in the field of low energy construction, in order to help deliver county-wide, government instigated CO_2 reductions.

The process of design and delivery of this project enabled the development of specific construction details applicable to cavity wall construction that minimise thermal bridging and maintain the low levels of air-permeability required to meet the Passivhaus Standard.

The client and the Green Building store considered it important to openly communicate the processes surrounding the design, construction and performance of this house. Throughout the process Bill Butcher kept a blog outlining the key issues experienced. This was published through the UK building magazine – *Building* but also on the Green Building Store website (Green Building Store, 2010). Details of the design and construction processes are also documented on the Green Building Store website which also hosts films about the development.

In conjunction to meeting the Passivhaus standard, this house was also tested against compliance with the CSH. Bill Butcher who was one of the project managers for this development believes that designing the house to the Passivhaus standard and then testing it for CSH compliance has helped to expose some potential flaws in the CSH and the energy

calculation methodology SAP, which is used for CSH and UK Building Regulations Part L compliance.

Testing the house for CSH compliance showed that the house would only achieve CSH Level 3, (which was the basic standard currently mandated for new social housing schemes in the UK at the time of this development). In the on-line blog, Bill Butcher raised questions about the suitability of the CSH standard as a mechanism for providing low and *'zero carbon'* housing in the UK, based on assumptions about its lack of rigour in comparison to the Passivhaus Standard. Referring to a report produced by the CSH assessor for the project, Bill Butcher wrote –

> *'The report points out that many buildings receiving higher CSH ratings actually perform worse than the Denby Dale Passivhaus in terms of space heating and airtightness but gain points in other areas, and sometimes through the use of inefficient and expensive bolt-on renewable technologies. The report notes that the Kingspan Lighthouse which gained CSH Level 6, is reported to have a higher heating demand and is less airtight than the Denby Dale Passivhaus Design'* (Butcher, 2009b)

Since completion this house has won many UK architectural design awards inclusive of the Royal Institute for British Architects (RIBA), White Rose Award for Sustainability in 2010, the bronze housing award and the client of the year award. (Green Building Store, 2010)

Technical Performance

The Denby Dale Passivhaus was designed to have a compact shape that is common to many European Passivhaus designs. This works to optimise the building's space to surface area ratio and regulates heat loss parameters. The final rectangular design was not however the first design promoted. The original design employed an 'L – shaped' plan. This was however abandoned when the shape proved to be prohibitive to achieving PHPP or Passivhaus energy performance compliance.

> *'Getting the right design has taken a couple of false starts, with the initial L-shaped design with a conservatory rejected for failing to perform to Passivhaus standards, after modelling with the Passivhaus Planning Package (PHPP) software'* (Butcher, 2009c)

Once the final rectangular form of the building had been decided upon the house was modelled using PHPP. The modelling achieved significantly different results for heating parameters depending upon the type of wall insulation modelled. These ranged between 14-19 kWh/m^2 a. A final design was decided upon with PHPP heating requirement of 15 kWh/ m^2 a.(Butcher, 2009c)

Building Fabric

This development was built using the cavity wall construction technique. Alternative 'green' materials and design details were however substituted for some of the more conventional materials and usual cavity wall design details that are frequently associated with more standard building projects of this type. According to the project managers, the materials used were however kept as quite conventional to help keep construction costs down to a minimum.

A cavity wall design detail that conforms to the requirements of the Passivhaus Standard was specifically developed for this project together with a lightweight aerated block detail that was used below ground level, due to its capacity to retain heat. Basalt resin cavity wall ties were also used instead of conventional steel ties thus minimising thermal bridges.

Particular attention was paid to the design of any junctions between different materials and around windows, doors and services penetrations which would have the potential to compromise either the required low levels of air-permeability or present opportunities for thermal bridging.

It was considered that achieving the Passivhaus Standard air-permeability parameters was more complex for this type of construction than some other building construction methods and had to be arrived at through the use of a wet plaster barrier applied to the interior walls, in conjunction with the use of air-tightness tapes and membranes. According to Bill Butcher

> *'The potential downside of cavity wall construction is that it relies on wet plaster to be the airtightness barrier on walls and junctions with doors, windows, floors and roof whereas timber frame construction can be lined with vapour barriers and airtightness tapes etc., so our cavity wall Passivhaus will demand greater attention to detail'* (Butcher, 2009d)

Standard range, market brand, mineral wool insulation was used throughout the scheme. This insulation was applied around the entire fabric so as to achieve a 'tea-cosy' effect with 300mm insulation applied to external walls, 500mm in the loft and 225mm in the ground.

Figure 27 - Denby Dale Fabric Performance

Fabric Performance	
Element	U-value/performance
Roof	U-value 0.096 W/m^2K
Walls	U-value 0.113W/m^2K
Ground	U-value 0.104 W/m^2K
Doors and Windows	U-value - average: 0.8 W/m^2K
Air-permeability	0.33 -1 @ 50 Pa
Heating - PHPP	15kWh/ m^2 a
Primary Energy - PHPP	87 kWh/ m^2 a

Building Services - Heating, Cooling, Ventilation, Lighting and Appliances

A Passivhaus certified MVHR unit was used for the main heating and ventilation strategy with additional heating and domestic hot water provided by a 4.8kW gas condensing boiler.

The boiler was over-sized for the project but was used due to unavailability of smaller gas condensing boilers at the time of construction. Additional demand for the boiler was created through the installation of a radiator, a heated towel rail and a duct heater for the MVHR system. (Green Building Store, 2010)

The heating system was designed in a similar way to that of the Larch house due to lack of robust weather data for the UK installed as part of PHPP at the time. This is described by the UK Passivhaus certifier Peter Warm on the Passivhaus Institut website. (PHI, 2012a)

Post completion, solar thermal panels were added to the roof to supplement heat requirements for the domestic hot water supply.

While PV panels were not included as part of the original design for this dwelling, the client later added PV panels, the cost of which was financially supported through government grant funding.

A double-height solar space is included on the south elevation of this house, this helps to optimise passive solar gain and maximise the use of daylight. This feature uses solar shading provided by deep roof overhangs and external venetian blinds together with extra shading provided by planting.

Low energy LED lighting has been used in most internal areas and a conventional gas cooker with re-circulating hood has been installed.

Cost

The aim for this project was to build a low energy dwelling as cost effectively as possible reflecting the budgetary constraints of a domestic owner/occupier. The cost of the Denby Dale Passivhaus was £141,000 this is equivalent to £1194/m^2 which represents an increase in cost of approximately 10-15% in comparison to a similar 'conventional' house (Butcher, 2009a)

According to the Green Building Store, this initial cost reflects the prototype nature of this project and it is believed that these costs can be reduced for future projects. This would be achieved through having completed the initial learning-curve process and also potentially through economies of scale for larger projects.

Research undertaken by the Passivhaus Institut in Darmstadt has shown that capital costs for Passivhaus buildings may initially be higher than conventional buildings, dependent upon construction type. These Capital cost rises are often related to the learning curves associated with designing and building to the Passivhaus standard. Recent calculations made by the Passivhaus Institut in Darmstadt, based on German house construction show that typically the cost increase is estimated to be approximately 7-8 %.(PHI,2012b)

> *'The improved thermal insulation necessitates more insulation materials and its application, better windows require an extra coated glass pane and an insulated frame, the heat recovery system will need ductwork…*

To be on the safe side, we will assume that an additional total investment of € 15000 was necessary in 2010, and in 2011 this is already reduced to less than € 12500. This was about 8% of the total average construction costs for such a house in Germany - and it's less than 7% already in 2011 with still existing potentials to lower the extra investment even more' (PHI, 2012b)

It has however taken approximately twenty years, since the early 1990's and the development of the first test Passivhaus buildings and the CEPEUS programme for costs to reduce to this level. Despite this there are now examples of Passivhaus buildings that are cost neutral in comparison to 'conventional' non-Passivhaus new build buildings, for example the Canolfan Hyddgen, but until the standard is more widely adopted in the UK and/or becomes the convention then costs have the potential to remain generally higher.

Scheme Implementation

This project was built by a small team of UK contractors from the Green Building Company. These contractors had prior knowledge of and experience with the construction of low energy buildings but they had not previously built to the Passivhaus standard.

All the designers and contractors were UK based and the materials were supplied by the Green Building Store. The original source of many of the materials and components was not however the UK, with air-tightness tape, doors, windows, membranes and MVHR units being manufactured elsewhere in the EU and supplied to the UK.

It was necessary to develop specific design details for the cavity wall construction to enable Passivhaus compliance.

Buyer/Occupant Feedback

The occupants of this house have expressed satisfaction with the development to date. They have also started to keep an on-line blog detailing their experiences of living in the house. The following quotation taken from the blog describes their early thoughts in relation to this -

'Six months in and we're finding that life in a Passivhaus is suiting us very well. The air quality and temperature is good – there's a pleasant warmth in the air – it's not hot, it's just comfortable. There's also a serenity about a Passivhaus, thanks to all the

insulation and triple glazing. We're actually finding that we are oversleeping some mornings because of the absence of outside noise' (Tunstall and Tunstall, 2010)

Many key issues are highlighted by the occupants in their blog, these relate to their need to amend their lifestyle. One important suggestion is that those who live in a Passivhaus need a standardised form of occupancy manual. This type of manual has been produced by some developments in Germany and Austria but has not been available for all Passivhaus developments.

'Although a Passivhaus is simple to live in, in many ways, it would be really good if a Passivhaus came with a manual, as things do change subtly with the seasons. It would also be really valuable to have a forum for people who live in Passivhauses to share ideas and experiences – there are still so few of us in the UK that this would be a valuable resource.'(Tunstall and Tunstall, 2010)

Conclusions

This project is important for many reasons. It is one of the first certified Passivhaus developments in the UK but it also shows that a Passivhaus can be constructed using the cavity wall construction technique. This construction method has not typically been used in continental European Passivhaus developments, but is frequently used in the UK. The use of this construction technique therefore required the development of specific new details.

The project also demonstrates the feasibility for UK designers and contractors to build to the Passivhaus standard and at 'affordable costs', despite the increase in comparison to a more 'conventional' design. Some of the costs were associated with the import of many vital components that were needed to build to this standard, with these having to be sourced from EU suppliers due to lack of availability in the UK. In relation to this it is particularly relevant to note that it was not possible to procure a small sized gas condensing boiler of suitable size for the project, with the boiler that was installed being over-sized. This was due to the fact that no gas boiler products currently exist on the UK market that are small enough to meet the required specification parameters of this type of individual Passivhaus.

The findings of this case study also suggest potential flaws that may exist in the UK CSH standard which have been commented upon by Bill Butcher the project manager in the blog.

Bill Butcher, Director of Green Building Store commented about this as follows:

> *"Jim Parker's research has confirmed what we have all suspected about CSH for some time. While we applaud the general approach of CSH in getting the construction industry to think about sustainability issues, we believe that it urgently needs to be revised to accommodate Passivhaus approaches more accurately. We would like CSH to get rid of SAP and incorporate the much more accurate Passivhaus Planning Package (PHPP) as its energy calculation methodology*". (Butcher, 2009a)

German Case Studies from Frankfurt and Berlin

Two specific German Passivhaus projects have been chosen as case studies for this research, these are the St. Jakob, family-friendly Passivhaus flats in Grempstrasse, Frankfurt am Main and The KlimaSolarHaus, in Bänschstrasse, Berlin.

These projects have been chosen as examples of mass rather than individual housing and both are located in central urban areas. What marks these projects out as different from some other Passivhaus projects in Germany and Europe is the use of community building techniques that were employed in each case to help develop a cohesive 'living group' who bought into the projects both socially and financially.

The projects were also chosen because they were located in two different regions within Germany. This is significant due to different climate conditions but also potentially construction industry culture and skills differences.

Despite both being multi-dwelling blocks of flats, the developments were designed in specifically different ways to meet the Passivhaus standard. The Frankfurt flats were designed as individual autonomous units with their own integral MVHR units, while the Berlin flats utilise a centralised MVHR and additional building services systems inclusive of a wood pellet boiler, solar thermal panels and grey water recycling. The development in Frankfurt is also an early example of a predominantly 'north facing' Passivhaus development.

These case studies are largely POE occupant feedback focused, with a weighting on interviews that were conducted with the residents at the beginning of December 2010. The willingness of residents of these developments to participate has been key to the success of these case studies. All respondents interviewed were happy to be involved in the interviews and gave their consent to being filmed and to their responses to questions being used in this thesis.

St. Jakob, Family –friendly Passivhaus Flats, Grempstrasse, Frankfurt am Main

Figure 28 - St. Jakob, Grempstrasse, Frankfurt

(BBC, 2011)

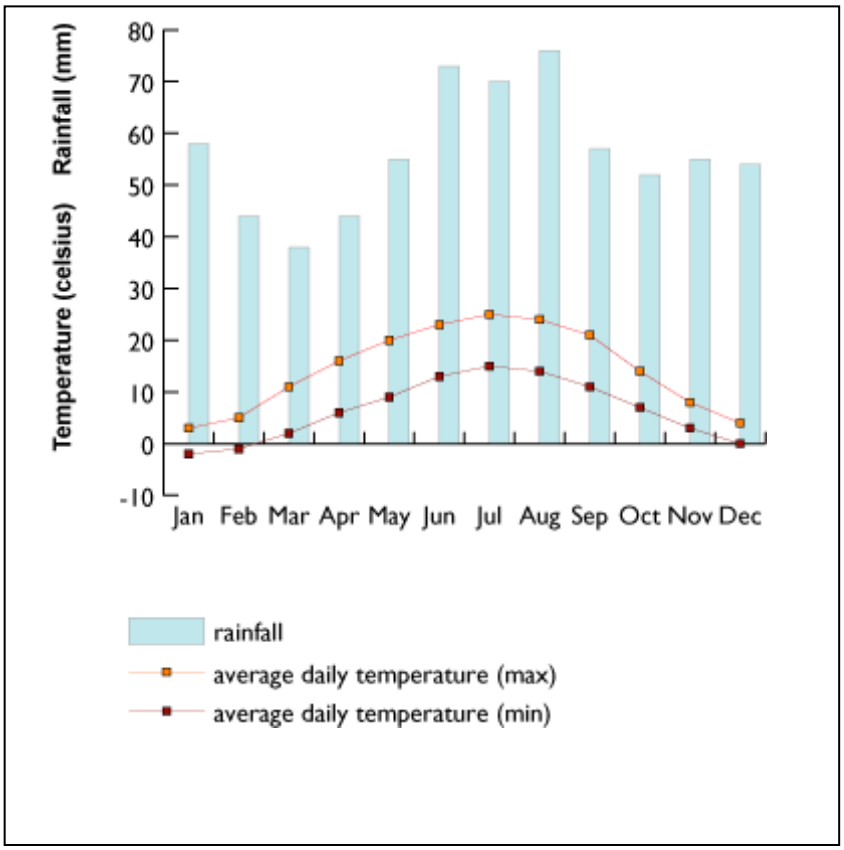


Figure 29 - Average annual weather data for Frankfurt-am-Main

Design Team

Client	Frankfurter Aufbau AG
Architect	Faktor 10 GmbH
Project Management	Frau Dipl.-Ing. Arch./Dipl. – Des. Petra Grenz
Contractor	Rasch & Partner Baunen und Wohnen GmbH

Introduction

The St. Jakob's project is a development of 19 Passivhaus flats in two separate blocks located in Grempstraβe in the Bockenheim district of Frankfurt am Main. This project was completed at the end of 2002 and has been occupied since the start of 2003. It was the first Passivhaus block of flats to be built in Germany and a notable early example of a 'north-facing' Passivhaus development. The overall size of the development is 2, 289.8 m^2 with a total living area of 1842 m^2. The average size of the flats is 97 m^2 but they range in size from 62m^2 to 116.9 m^2. (Peper et al., 2004)

Since the completion of this project, Frankfurter Aufbau AG, the housing association who built this development, now only builds housing developments to the Passivhaus standard. This is also in accordance with the current local Frankfurt am Main planning requirements, which ask that all new public housing is to be built using Passivhaus technologies (Laible, 2010a) as explained in the Innovation chapter of this thesis.

The flats were specifically designed to meet the Passivhaus standard and therefore to be low energy. They were also designed to be suitable and affordable for families. It was intended that the flats would help to fill a gap in the availability of this type of accommodation in central Frankfurt and to prevent families leaving central Frankfurt in favour of cheaper accommodation outside the city centre. Initially, the flats were occupied by 59 residents with 23 of these being children under the age of 18 years.(Peper et al., 2004)

Frankfurter Aufbau AG developed St.Jakob on land owned and leased by the local church which enabled them to reduce sales costs for the flats since there were no overhead purchase costs for the site.

St.Jakob is situated close to the centre of Frankfurt and 100m from the nearest underground station; Kirchplatz. Shops, a hospital, schools and kindergartens are also located close to this development. The flats back onto an area of green space and gardens which act to provide

both a ‘breathing space’ for this area of Frankfurt and recreational facility for residents of the flats.

The St. Jakob project is a five storey development which comprises a mixture of two storey maisonettes on the top and bottom floors with more conventional one storey flats between the floors. All the flats have balconies, but unusually for most German flats and houses, this development has no cellar for individual storage. The cellar space is instead used to house the gas heating facilities for the domestic hot water and top-up space heating. Additional storage, garage facilities and bicycle sheds are provided separately on the site. Specific washing drying facilities are included as part of each flat with a ‘Swedish’ drying cupboard located in the bathrooms. This is linked to the whole house ventilation system and helps to reduce overall energy use from the flats.

> *‘Eine Besonderheit sind in jeder Wohnung bereits ein gebaute Trockenschränke für das Wäschetrocknen, die in den Abluftstrang der Wohnungslüftung integriert sind und eine hocheffiziente Wäschetrochnung mit extreme geringen Stromverbrauch’* (Peper et al., 2004)

My translation of this is –

> *‘ A special feature is that in every flat is an inbuilt drying cupboard for drying washing, this is integrated into the exhaust air supply for the flats and is a highly efficient method for drying washing using very little electricity’*

A special children’s play area and gardens are included as part of this development and the flats have a green roof. The roof is used to provide thermal attenuation for the building and increase biodiversity in the area and is not used as recreational space. It is managed by the residents.

Technical Performance

St.Jakob is a steel frame and concrete construction building with high levels of insulation and low air-permeability, in accordance with the design parameters of the Passivhaus standard. Each flat was individually air-pressure tested to check for Passivhaus air-permeability compliance.

Each flat is designed with its own individual MVHR unit accommodated in an easily accessible location in a specific 'technik' or technical room adjacent to the entrance of each flat. The location of the MVHR units is unobstructed and at low level. It allows for ease of access for maintenance and for residents to change the filters. The technical rooms are also used by residents for additional storage space/cloakroom.

Top-up space heating and domestic hot water is provided via a central gas fired boiler linked to a district heating domestic hot water supply. This is supported with the use of individual heat exchangers in each flat. Use is made of exposed thermal mass within the flats and maisonettes to help moderate internal temperatures throughout the year.

Energy Design and Performance

The fabric and energy use parameters for the St.Jakob development were designed in accordance with the Passivhaus standard and met these design requirements. At the time of design, Frankfurter Aufbau AG estimated that this entire project would achieve CO_2 savings of approximately 42,000 kg per annum in comparison to 'conventional' similar flats(FAAG, 2001).

The actual energy in use for the two blocks A and B was monitored by the Darmstadt Passivhaus Institut between 01 June 2003 and 31 May 2004. The results from this monitoring showed that the development performed well in comparison to designed energy use criteria

Figure 30 - Grempstrasse Fabric Performance

Fabric Performance	
Element	**U-value/performance**
Roof	U-value 0.098W/m^2K
Walls	U-value 0.12W/m^2K
Ground	U-value 0.112W/m^2K
Doors and Windows	U-value - windows: 0.87W/m^2K Doors: 1.0W/m^2K
Air-permeability	Flats individually tested with 100% compliance to meet the Passivhaus standard throughout – average 0.30 -1 @ 50 Pa but ranging between 0.20 -1 @ 50 Pa – 0.45 – 1 @ 50 Pa.

Designed Energy Performance using PHPP (Passivhaus Planning Package) *Figures taken from – 'Ein nordorientiertes Passivhaus – Messtechnische Untersuchung und Auswertung von 19 Wohnungen im Passivhaus-Standard in Frankfurt – Bochenheim' by Dr Wolfgang Feist, Sören Peper and Dr. Ing. Rainer Pluger*(Peper et al., 2004)	
Block A - heating	12.8 kWh/ m^2 a
Block B - heating	15.2 kWh/ m^2 a
Block A + B – heating, domestic hot water and MVHR	55 kWh/ m^2 a
Block A – heating – post air pressure test	10.4 kWh/ m^2 a
Block B – heating – post air pressure test	14.8 kWh/ m^2 a
Block A – primary energy	120 kWh/ m^2 a – allowing for the use of low energy electrical appliances
Block B – primary energy	120 kWh/ m^2 a – allowing for the use of low energy electrical appliances
Monitored Energy Performance	
Block A - heating	10.5 kWh/ m^2 a
Block B - heating	14.5 kWh/ m^2 a
Block A + B – heating, domestic hot water and MVHR	49.6 kWh/ m^2 a
Block A – primary energy	119,9 kWh/ m^2 a
Block B – primary energy	119,9 kWh/ m^2 a

The information in the table above is taken from reports produced by the Darmstadt Passivhaus Institut and the Passivhaus Institut website(PHI, 2012a). These figures appear to show good in-use monitored energy performance. The monitored primary energy use

records for both Block A and B are very close to design performance targets and could require further monitoring for verification in future. In conjunction with the measured energy use performance figures correlating well with designed parameters, the development also appeared to perform well in relation to other factors. These included maintaining comfortable indoor temperatures in both Winter and Summer with average room temperatures recorded during the heating season of 21.3° C and those in an exceptionally hot summer, when external temperatures in excess of 29° C were reached, of between 3 K and 11 K below this. (Peper et al., 2004)

Cost/Value

The build cost for this entire development was €2,235,000 (inclusive of VAT) (Peper et al., 2004). All the residents interviewed thought that the flats were affordable to purchase comparative to other similar accommodation in Frankfurt.

Scheme Implementation

The project design team and contractors were all chosen because of their prior experience with delivering Passivhaus projects in Germany. This meant that the project was delivered without many of the initial 'learning curve' difficulties that are often associated with designing and building a Passivhaus development.

Residents of St.Jakob were invited to become part of this project through an advertisement that was posted in a local Frankfurt newspaper. Once sufficient interest in the project had been raised, a series of meetings, chaired by the architects were held in the local church which is situated in Grempstrasse close to the flats. These meetings were designed to provide information for residents about the Passivhaus standard and the proposed development, so that they could gain an understanding of the project before buying into it. This included for communicatin about any differences that might be experienced in comparison to living in more 'conventional' flats. These meetings were also designed so as to help develop community cohesion between the residents of the flats prior to their design, construction and occupation.

Buyer/Occupant Feedback

The St.Jakob flats are owner occupied. For this occupancy feedback study, residents of two flats were interviewed using a brief series of interview questions. The interview questions and their German translations are shown below. The interviews lasted approximately 30

minutes each and the aim of these interviews was to try and gain a first-hand understanding of what it is actually like to live in this development and to gauge occupant satisfaction. The interview questions were chosen from some previously used as part of research conducted for the InCluESEV (Interdisciplinary Cluster on Energy Systems, Equity and Vulnerability) research programme. They were chosen because of their simplicity and the fact that they would be easy to understand for a 'non-technical' lay person. They were also chosen to allow occupants to discuss a wide range of parameters relating to satisfaction with their homes within a short number of questions and time parameters, thus helping to keep interview concise.

Figure 31 - POE Interview Questions

	Interview Questions	**Interviewfragen**
1	How long have you lived here?	**Wie lange wohnen Sie hier schon?**
2	What is it like to live here?	**Wie ist es hier zu leben?**
3	How did you come to live here?	**Warum wohnen Sie hier?**
4	Is there in your eyes anything different or special about living in this building?	**Was ist besonders oder anders hier zu wohnen? Zum Beispiel im Vergleich zu einem normalen Haus oder einer normalen Wohnung**
5	How much do you feel you know about this development/ where did the information come from/ how was it passed on to you?	**Nach Ihrem Empfinden wie viele Informationen habe Sie über dieses Haus? Woher haben Sie diese Informationen? Und wie haben Sie diese erhalten?**
6	What do you think of it?	**Was halten Sie von diesen?**
7	Has it made you do things differently?	**Haben diese Informationen Ihren Lebensstil verändert?**

8	Have you made any changes to your home?	**Haben Sie Ihre Wohnung renoviert oder verändert?**
9	If you had the choice (and money), what would you change in your home?	**Was würden Sie in Ihren Wohnung verändern, wenn Sie die Wahl und das Geld hätten?**
10	If they will build another version of this development, what should they change?	**Wenn noch eine ähnliches Haus gebaut wird, was sollte anders gemacht werden?**
11	Any other comments?	**Noch etwas?**

The interviews were undertaken with three residents of St.Jakob, the first was Jana Müller-Gerbes a journalist and mother of two children, a girl aged 15 and a boy 9. The second interview was conducted with a retired couple Melanie Hartlaub and Thomas Feber, who were interviewed together in their flat.

All the interviews were conducted in German, the key answers to the interview questions have been translated and entered into the questionnaire forms below as bullet point responses to document the responses.

Occupant 1 St.Jakob - Jana Müller-Gerbes

	Interview Questions	**Answers**
1	How long have you lived here?	- *For almost 8 years the family moved in in January 2003* - *It was a really cold Winter when we moved in with temperatures as low as minus 17 degrees C.*
2	What is it like to live here?	- *Great for many reasons* - *The house is great and so is the area* - *We experience constant room temperature here* - *I really like that we are always warm and*

		comfortable - *It is draught free* - *Where we lived before in an old flat it was always too cold* - *The children can play directly on the floor without draught problems* - *I have now become very sensitive to draughts and notice when I visit friends in normal flats – e.g. if there is a window behind where I am sitting (not an open window!) or a part open door I really notice it* - *Here you can sit with your back against the window in the cold weather* - *In summer, although we live under the roof, if we make sure that the windows are shut during the day when we are out and the blinds are down then it keeps really cool in here* - *Both the heat and the cold stay outside* - *As long as you learn to deal with the sun and light which can bring heat in during the summer you can control the living space temperature well* - *In Winter as soon as the children have gone to school, I make sure that the blinds are up so that light comes in to help warm the place up*
3	How did you come to live here?	- *It was actually by chance* - *We were looking for a bigger flat* - *We were a family of three and had just had another son*

		- *We were looking for a four bedroom flat in this area of town because we did not want to leave the area* - *Then we heard about this project from a newspaper article* - *We had never heard of Passivhaus before* - *We did some research into Passivhaus and were very impressed with the idea* - *We liked the fact that you could save energy and therefore money, also that it was environmentally friendly* - *The flat was also the perfect size* - *The flats were specifically designed for families* - *We liked the fact that there are 19 different family units here with 26 children between them, which is unusual for Frankfurt and Germany as a whole*
4	Is there in your eyes anything different or special about living in this building?	- *The heat given off from the appliances such as the dishwasher is very apparent this is not the case in normal flats* - *The windows and walls don't only work as thermal insulation but as sound insulation* - *Many people thought we were mad living right next door to a church because the bells would wake us up in the morning, but we don't hear them* - *Paula our daughter plays the piano and the neighbours never hear anything*
5	How much do you feel you know about this	- *Meetings were held in the church in this street for all potential residents at which the*

	development/ where did the information come from/ how was it passed on to you?	*architects explained what a Passivhaus was and what it would mean to live in one, so we had an idea before we bought the flat and moved in* - *Regular meetings were held with all the final residents during the design and construction process to build up a sense of community* - *Written information about the development and the Passivhaus standard was provided by the architects*
6	What do you think of it?	- *This was well managed and useful*
7	Has it made you do things differently?	- *We need to be a bit careful we can't just leave the balcony door open all the time in the middle of winter or the flat would cool down and it would take a long time for it to warm up again* - *We need to be a bit more careful generally* - *We need to make sure that the front door is properly shut* - *We notice that the corridor from the front door is a bit cooler than the rest of the flat* - *We need to close the bedroom doors for the rooms below (the bedrooms are on the floor below) if the weather is really cold so as to stop the heat rising upstairs – it is not a big problem but it can be about 2 degrees colder downstairs than up because of the heat rising* - *In an old flat you could open the window for a long period then shut it and quickly put the heating on high – it is not possible to do that here or it would get too cool*

		- *Actually it is not a big issue as it is really warm enough in here* - *In summer we must make sure to pull the blinds down and* - *If it is really hot outside we must make sure that all the doors and windows are shut* - *If the blinds are down and the windows are shut then even in a hot summer like the last the flat will remain cool – not like an air-conditioned flat but comfortable* - *One has to learn new thing but one feels that one has more control over ones own environment*
8	Have you made any changes to your home?	- *No not yet structurally* - *We have painted the walls because of the children touching them with dirty hands*
9	If you had the choice (and money), what would you change in your home?	- *Nothing* - *I would buy another one* - *This has nothing to do with it being a Passivhaus but we could do with some more storage space we don't have a cellar* - *Buy the next-door flat and knock through*
10	If they will build another version of this development, what should they change?	- *I would make it bigger* - *It would be better bigger for when the children get older*
11	Any other comments?	- *I think we have become more conscious of the environment overall since living here* - *We can't have an open chimney that is not possible in a Passivhaus* - *We are very happy to live here*

		- *An anecdote – we are aware that one of our neighbours has bought a small electric fire which they use in the living area*

Occupants 2 and 3 St.Jakob – Melanie Hartlaub and Thomas Feber

	Interview Questions	**Answers**
1	How long have you lived here?	- *Since January 2003*
2	What is it like to live here?	- *Great because of the house and the location* - *We think that a Passivhaus is suitable for all diffent types of people inclusive of for those living in social housing but more care would need to be taken to make sure that everything was working because people do things out habit and those habits would have to change* - *You need to change your life-style to live here but not too much* - *You need more instructions about how to live in a Passivhaus and the instruction information needs to be interesting*
3	How did you come to live here?	- *We heard about the project by chance when we read about a low energy house that was going to be built in this area in a newspaper article in 2001* - *When we first went along to a meeting we didn't take it very seriously* - *But then we became quite impressed with the idea* - *There were more people who wanted the flats than flats that were available so we had*

		to put in an application for the flat - *We were lucky to get the flat that we wanted* - *We started to go along to the future residents meetings and became more and more interested in the project* - *We used to live in a beautiful old flat just around the corner and it was not easy to leave this but then we became impressed with this new development* - *We went to the first meeting in the church on this street where the architects presented the project, there were about 400 people there* - *We had never heard of Passivhaus before this* - *There were many reasons why we wanted to live here*
4	Is there in your eyes anything different or special about living in this building?	- *Most importantly we don't have any heating* - *When we moved in it was just like today, cold and with lots of snow and we visited another Passivhaus to check out whether it would be ok without heating* - *We always have fresh air, sometimes it is a bit dry* - *In Winter we always have the window shut and in summer we open the windows* - *We can't put nails or screws into the wall that are longer than 4cm long* - *Cables cannot be chased into and ceilings with exposed concrete soffits such as in our bedroom and study and non-top floor flats* - *We need to maintain the windows once a year by greasing the rubber parts/seals with*

		vaseline to ensure that they remain soft and do not crack therefore letting heat/cold into the building - *We need to generally be more careful with maintenance* - *This maintenance for the MVHR also costs money* - *We need to change the filters once a year – some do this twice a year* - *We need to be a bit more careful how we live* - *In our 93 m^2 flat – we pay €115 pro annum for heating and hot water* - *Electricity is a similar cost as before* - *However we were given info on how to save electrical energy at the meeting* - *It makes you more conscious of energy and energy use to live here*
5	How much do you feel you know about this development/ where did the information come from/ how was it passed on to you?	- *From a year before the development was complete there were lots of meetings with the residents at which issues were discussed about living in a Passivhaus* - *We became more and more interested in the idea of a Passivhaus and it was exciting to meet with lots of new people* - *I was very impressed with the explanation of the Swedish cupboard in the bathroom that was a key selling point, because it made me think how much they had thought this project through*
6	What do you think of it?	- *We thought it was good*
7	Has it made you do things	- *Yes a bit but many changes have come from*

	differently?	*the flat and the location* - *We have a balcony for instance that operates as another room in summer and we live in an area with lots of green outdoor space* - *The changes have been in maintenance and being more careful about how we live*
8	Have you made any changes to your home?	- *No* - *We had the opportunity to work with the planning of the flats before hand and haven't moved anything* - *During the design phase, we had the opportunity to make small changes to the layout but we didn't because this would have meant extra costs* - *What we did chose that is different from most of the other flats was to use natural paints and plaster* - *Our plaster absorbs more moisture – this is an advantage in a Passivhaus because they are dryer than other flats* - *But you can use house plants to help with the dry air* - *And you can dry washing openly outside of the Swedish cupboard* - *We think that because of our natural plaster we have a better air-quality in terms of moisture than the other flats – we think*
9	If you had the choice (and money), what would you change in your home?	- *The fit-out was relatively cheap – we would go for a more expensive fit-out* - *We don't like the cable containment or the sockets etc*

		- *The parquette floor is very sensitive, we would change that* - *Some other people have put tiles in their flats* - *Although noise from outside isn't a problem, noise within the flat can be – it is possible to hear everything from downstairs* - *this may be a problem since this is a maisonette with an open stair-well*
10	If they will build another version of this development, what should they change?	- *That they should use natural plaster* - *We don't understand why the MVHR room does not have a connection to the overall ventilation system itself i.e. inlet/outlet* - *They have now built more modern versions with slimmer and lighter windows* - *They need to do something with the internal noise* - *Apart from that not much*
11	Any other comments?	- *Not really*

Summary

When examining the resident's responses to the questionnaires, it is apparent that while they indicate that they are happy to live in this Passivhaus development and are satisfied with it and its facilities, life-style changes and new behaviours had to be adopted to enable them to successfully live in it. These behaviour changes relate to learning to live without 'conventional' space heating and adapting to whole house mechanisms such as the MVHR together with learning to open and close windows appropriately to control thermal comfort, particularly in summer. Once these differences in comparison to living in a 'normal' dwelling were understood then this behaviour became 'normal' in itself.

The satisfaction expressed by the occupants of this development in relation to, low heating bills, the overall quality of the building and the sense of community that has been developed throughout the design, procurement and implementation of this project, has

been good. However experiences in relation to comfort and indoor air quality has exposed some concerns expressed by the second and third respondents who commented upon dry indoor air-quality and some issues relating to internal acoustics and louder sounds in this acoustically sealed environment

Of these factors the comfort levels and low heating bills are specifically associated with a Passivhaus development as are those relating to dry indoor air-quality and acoustics. Other factors relating to build quality and sense of community could however also have been achieved with a more 'conventional' non-low energy building.

The behaviour changes that were needed to allow the residents to successfully live in this Passivhaus development were not highlighted as major issues that had a negative impact on their life-styles. Instead these changes related to a slightly more active or adaptive approach to ensure thermal comfort in all seasons. These behaviour changes raised occupant awareness of comfort issues and energy consumption in comparison to experiences when they had previously lived in 'conventional' dwellings. The residents became more conscious of heat loss or gain through open windows especially when they realised that if they opened windows for long periods of time during the heating season that this would compromise comfort and that there would be a delay before the apartment could reach a comfortable internal temperature, as in comparison to living with a correctly installed individual gas boiler central heating system.

In the summer, care was taken by the residents to make sure that the external heat penetration through windows was moderated through the use of shading and controlled window opening to allow for natural ventilation, thus creating an optimum cool thermal environment.

One resident stated that they needed to consider the maintenance of the windows by maintaining air-tight seals through 'greasing' them to prevent cracking and air-leakage. Residents also had to make sure that the MVHR system was functioning correctly by changing filters when necessary. The retired couple who are on a fixed income did mention that there were some extra costs associated with changing the filters.

Other factors that were highlighted as being different about living in a Passivhaus were air-quality which, as previously mentioned was perceived as being better but drier than living in a 'conventional' home. In this particular development the architects installed a special 'Swedish cupboard' or drying cupboard in the bathrooms which is connected to the whole house ventilation system. This works not only to save energy from the clothes drying process since a drying machine is no longer needed, but moderates internal moisture/humidity levels. House plants were also used to help moderate internal humidity levels as were porous internal finishes in Thomas and Melanie's flat.

Acoustics and noise were mentioned both positively and negatively as part of the development. The residents were happy that the building fabric performance and windows meant that external noise levels were well attenuated or even blocked. This included control of noise between different flats in the development. Thomas and Melanie did however mention that it was more difficult to control noise levels within their maisonette flat which they attributed to the fact that it had been designed with an open stairwell between the two levels. Neither of these two parties had undertaken any major renovations to their apartments since they had moved in.

One of the factors that marks this development out from many 'conventional' dwellings is the design and procurement process which directly involved the residents as decision makers in the design and management of their accommodation. This enabled the residents to understand any behaviour or life-style changes that might be associated with living in a Passivhaus before they bought and moved in to their apartments. It also enabled them to have direct input into the design of their apartments. The residents therefore not only bought into this development on a financial level, but also on a social level and to provide long-term homes for themselves and their families.

The KlimaSolarHaus, Bänschstrasse, Berlin

Figure 32 - The KlimaSolarHaus Berlin

(BBC, 2011)

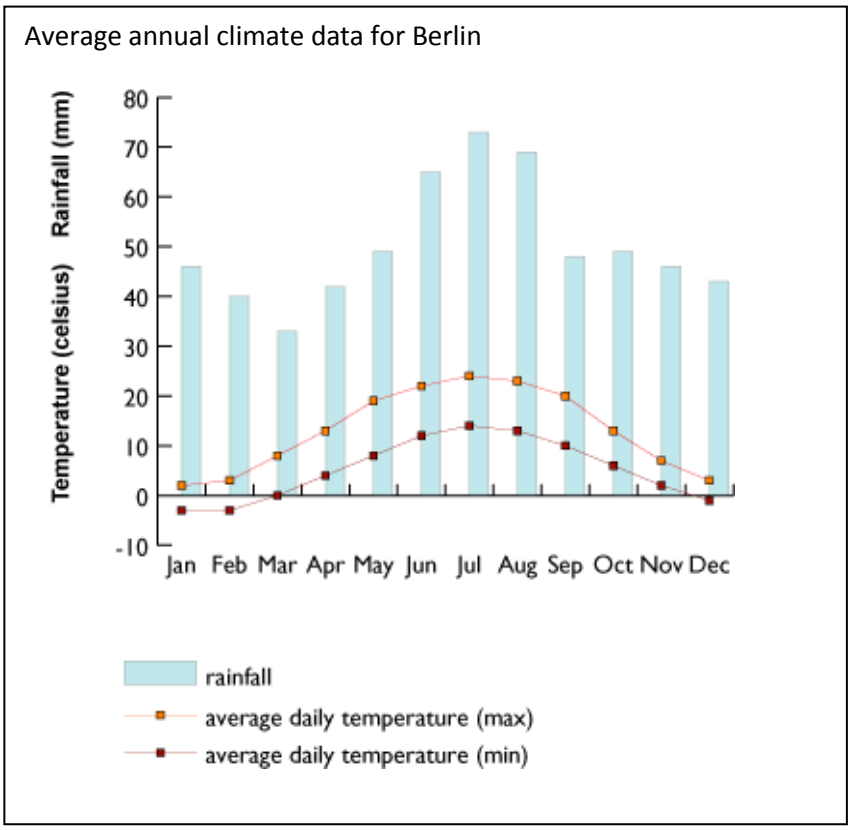


Figure 33 Average annual climate data for Berlin

Design Team

Client	KlimaSolarHaus Berlin GbR
Architect	Dittert and Reumschüssel
Mechanical and Electrical Engineering	Fa. Ökoplan
Landscape Architect	Susanne Widiarto
Contractor	Schaefer/Schulz GmbH
Passivhaus Consultants	ARGE Lehmolltec and Jirka + Nadansky Architekten

Support Team/Additional Consultants

Planning Consultant	Dr. Lausch GmbH and Co. KG
Team Planning Support	SPI – Sozialpädagogisches Institut Berlin
Solicitor	Axel Sawal
Conflict Mediator	Dr. Reinfried Musch
Financial Support	GLS Bank
Financial Support 2	KfW (Kreditanstalt für Wiederaufbau)

Introduction

The Passivhaus development in Bänschstrasse, Friedrichshain, Berlin, is a five storey 2,130 m^2 building containing 19 flats of varying different sizes which are inhabited by 46 people inclusive of families, couples and individuals from a range of ages. This building was developed on an old World War 11 bomb site in an area that was formerly in East Berlin. It was completed in September 2008 and occupied from February 2009.

The project was initiated by Christoph Hackbart and Thomas Fiedler in September 2004 when they developed a plan to build a block of Passivhaus flats through the mechanism of a housing association or community group. In January 2006 Christoph and Thomas identified a suitable site for their proposed development and in March of that year they held their first meeting with potential residents and members of the new housing association. In August 2006 the site in Bänschstrasse was purchased and the housing association was inaugurated in April 2007. The project commenced on site in January 2008.(KlimaSolarHaus, 2009)

Technical Performance

Fabric Performance	
Element	**U-value/performance**
Roof	U-value 0.11W/m^2K
Walls	U-value 0.15W/m^2K
Ground	U-value 0.17W/m^2K
Doors and Windows	U-value - average: 0.8W/m^2K
Air-permeability	0.4ach - 1 @ 50 Pa
Designed Energy Performance using PHPP	
Heating	8 kWh/ m^2 a
Primary Energy	42 kWh/ m^2 a

(PHI, 2012a)

Figure 34 - KlimaSolarHaus, Technical Performance

The designed energy use parameters for this development are extremely low even by Passivhaus standards. They may partly be attributed to the use of centralised systems and the use of a wood pellet boiler to provide domestic hot water and top-up space heating.

Cost/Value

The build cost for these flats was €2100 /m^2 (PHI, 2012a) or approximately €4m(Browne, 2012). One of the residents commented that it was cheaper to build these flats than purchase a newly renovated non-environmentally friendly flat in the same area of Berlin.

Scheme Implementation

Residents of Bänschstrasse were invited to become part of this project through an advertisement that was posted in a Berlin newspaper. Once sufficient interest in the project had been raised, a series of meetings, chaired by the project co-ordinators were organised. These meeting were designed to provide information for residents about the Passivhaus

standard and the proposed development, so that they could gain an understanding of the project that they were buying into inclusive of any differences that might be experienced in comparison to living in more 'conventional' flats. These meetings also formed the basis of the development of the housing association that is the current owner/occupiers of Bänschstrasse.

The KlimaSolarHaus experienced some initial teething problems with the design team when the original Berlin architect was replaced with an architect from Hamburg who had more experience with building Passivhaus buildings. During construction there were some disputes with the main contractor who contested some of the costs for finishing the project.

Buyer/Occupant Feedback

Interviews with three different occupants of the KlimaSolarHaus were supplemented with an additional unstructured interview with Jörg Meyerhoff who is also a resident of the house but has acted as a representative of the tenants and the housing association. Jörg explained some additional background information about the house but was also responsible for providing a tour of the house and introductions to those interviewed.

Occupant 1 KlimaSolarHaus – Robert

	Interview Questions	**Answers**
1	How long have you lived here?	- *For one and a half years since the middle of 2009*
2	What is it like to live here?	- *I don't think it is really any different from living in any other house in the day-to-day living*
3	How did you come to live here?	- *When I joined the scheme I knew relatively little about Passivhaus* - *I liked the idea of a low energy house but the knowledge that I have gained has come over the four years that it took to build it* - *From joining together with a group to planning things with an architect to finding a builder and then getting planning permission*

		and then actually building it - *We compared prices to what we could find – we were looking for a flat to buy and the alternatives we found nice renovated flats of the same size, and they actually cost more than this house ended up costing* - *So it was partially economic reasons – as we could afford a flat of the same cost as one which wasn't low energy, this was a very big attraction*
4	Is there in your eyes anything different or special about living in this building?	- *In Summer we tend to close the blinds particularly on the south side then the building is much cooler than you would expect in Summer*
5	How much do you feel you know about this development/ where did the information come from/ how was it passed on to you?	- *Most of the information that I received came from the two people who founded the building group prior to and during the construction of this house over 4 years* - *They had been working on the project for several years before they found the site and had the courage to go ahead with the project* - *But Passivhaus is an area where one can get a lot of information* - *It is not that complex* - *I found it very easy to get information on the internet*
6	What do you think of it?	- *great*
7	Has it made you do things differently?	- *I don't think I have had to change my lifestyle at all by living in a Passivhaus* - *There is nothing we do that is different, it is very simple*

		- *We switch the thermostats on on the radiators and leave them like that summer and winter and the heating comes on when it is needed which tends to be only when it goes sub-zero outside* - *So generally speaking it has had no effect at all*
8	Have you made any changes to your home?	- *The flat is only a year and a half old so there haven't been any changes at all*
9	If you had the choice (and money), what would you change in your home?	- *We have had some problems with the technologies which haven't always worked since day one* - *But overall between the house and the building group there is nothing I would want to change* - *We have had some difficulties with the solar thermal the first year was not very successful but it is getting better – we are still working with the designers and the contractors for this* - *We have a wood pellet heating system, that we have had to adjust to make it more efficient* - *It is best that it doesn't go on and off to often so we have tried to increase the length of time that it is on* - *And the other thing is the grey water system which possibly people have had to learn about – and not to put things in the shower water and how often to clean the filters but that is to be expected*

		- *With the MVHR there have been no big problems with that – occassionally when it is very cold outside e.g. minus 15 it can ice up and then you have half an hour without ventilation which tends to occur at night-time but otherwise then it comes on again but that is all automatic* - *We have to change the filters but that is a maintenance firm who looks after that* - *Generally speaking the venilation system has been very successful, some flats found that they were a little bit noisier than expected and ventilation wasn't as even between each room but we seem to be solving those problems* *Generally speaking most people are very happy with it*
10	If they will build another version of this development, what should they change?	- *If I was going to do the whole thing again, I don't think I would put in a wood-pellet heating system, I don't think that is ideal in a city* - *Because it is used so little, I think we would have been better with a remote heating system or gone on to gas*
11	Any other comments?	- *I see no reason why anybody couldn't live in a Passivhaus* - *You may have to change your habits a bit - you would have to get used to not opening the windows so much in Winter , but otherwise there is no real difference* - *I am still very euphoric about living in the*

		house not because of the building but because of the people living here although it is the house the holds us all together - *Going through the difficult process of the build working as a building group you learn how different people are and how they react and having this one common thing between us that we wanted a low energy house was a very unifying thing* - *The bills seem to be as expected as in cheaper than a conventional house – my heating bills are a quarter of what they used to be* - *Electricity bills are essentially the same, that doesn't change really* - *We have gas for cooking in the house but that is so low that we hardly notice it*

Occupant 2KlimaSolarHaus – Sabine

	Interview Questions	**Answers**
1	How long have you lived here?	- *Since the summer of 2009*
2	What is it like to live here?	- *Actually very pleasant*
3	How did you come to live here?	- *I don't know what is like in the UK but pensions are not so large here and are likely to remain fixed* - *All other costs such as health, tax and other bills will rise* - *So cost was a big consideration and I wanted to stop being dependent on oil and gas*
4	Is there in your eyes	- *You have to get used to living here*

	anything different or special about living in this building?	- *For example in a normal house you would either turn the heating down really low or turn if off completely if you go travelling* - *In this house you leave it on* - *In a normal house even in this type of cold temperature you can open the windows to bring in air but here you should not do this in the same way* - *We had a situation last winter where the temperature in the whole house started to go down continually until we were suddenly at 17 degrees C and nobody knew what caused this* - *Then it turned out that some of the people in the flats above had turned their heating off because they decided that it was so nice and warm that they didn't need any heating and this affected the entire house* - *We had to learn to change the habits of a lifetime* - *In summer it is cooler than in other buildings because of the MVHR* - *Even last summer when it was really hot I didn't have a temperature more than 25 degrees C when other flats in other buildings had 30 degrees*
5	How much do you feel you know about this development/ where did the information come from/ how was it passed	- *We have information through the building group (housing association) and we have developed that information over the 3 years before the house was built* - *We made all the decisions in relation to this*

	on to you?	*house together*
6	What do you think of it?	- *There were always some of the group who knew more or who had read more than others about Passivhaus and they helped the others who knew less*
7	Has it made you do things differently?	- *Living in Berlin has changed my lifestyle more than living in this flat* - *I find it quite luxurious that I can leave all the internal doors in the flat open here because there is the same temperature everywhere* - *I used to live in the family house in Bavaria where I would heat one room up and then keep the door shut because the rest of the house was cold*
8	Have you made any changes to your home?	- *No because we have really only just moved in* - *But many of us worked with the architects during the design phase to change the plans* - *I had an extra bathroom with guest WC put in my flat that was the only modification* - *I haven't taken any walls out or added any new ones*
9	If you had the choice (and money), what would you change in your home?	- *I would probably make my extra bathroom a bit bigger*
10	If they will build another version of this development, what should they change?	- *Actually I would do it all again*

11	Any other comments?	- *The MVHR in my flat is relatively loud but in other flats it is not* - *The technicians don't know why that is, they have an idea what it could be but they haven't found a solution yet* - *With noise we don't really hear anything from outside however we can just hear the children from the school yard outside*

Occupant 3 KlimaSolarHaus – Renate

	Interview Questions	**Answers**
1	How long have you lived here?	- *Since Summer 2009, I was one of the first to move in*
2	What is it like to live here?	- *Very pleasant* - *I used to live in a small family house until the family split up and I thought that it was too big and too much for me - here I have a manageable space*
3	How did you come to live here?	- *I am a pensioner and 67 years old* - *I used to live in a small village then the family separated* - *At my age I wanted to live in a city to be near people and be with other people that I like and not be dependent on a car* - *I liked the fact that it is environmentally friendly and a Passivhaus* - *Since the Chernobyl accident I have been very interested in the environment* - *I also have a relatively small pension and I don't want to spend all my money on living costs*

4	Is there in your eyes anything different or special about living in this building?	- *We are a housing association and before we moved in we had regular meetings to plan the development of the house* - *It feels good to live here*
5	How much do you feel you know about this development/ where did the information come from/ how was it passed on to you?	- *The two people who founded the project provided initial information then we found out things together* - *It was possible to find information about Passivhaus via the internet* - *We had to develop information about living in a community*
6	What do you think of it?	- *Generally good because we talked about it between us*
7	Has it made you do things differently?	- *Yes my lifestyle has changed because I used to live just outside Berlin and now live in the city* - *I used to go swimming in the lakes in the summer and walking in the woods in winter, naturally I can't do that here* - *I don't use the car very much any more* - *I don't need to go out of the house for company I can just go and visit people in this building* - *We used to live in a house where with heating from an oven when I was a child and heat up one room only* - *Living in a Passivhaus is a different way of keeping warm/producing heat*
8	Have you made any changes to your home?	- *We were all involved in planning our own flats with the architects* - *But I haven't made any changes since*

9	If you had the choice (and money), what would you change in your home?	- *This is the smallest flat and I would make it about 10m^2 bigger* - *I find the entrance zone a bit narrow* - *But I have enough space for my needs*
10	If they will build another version of this development, what should they change?	- *I would also make a small Winter garden*
11	Any other comments?	- *It is naturally cheaper to live here than if I lived alone in a little house* - *I hope that the costs will stay low – heating costs for us in Germany are the deciding costs* - *It is great here*

Interview with Jörg Meyerhoff

A further unstructured interview was undertaken with Jörg Meyerhoff who is a resident of the KlimaSolarHaus but who has also acted as a representative for the project. He explained more about the background context to the development and how the residents had collaborated in a formal legal agreement to form a housing association which procured, bought and manages the building.

> *'the financing of this project was very important, because we knew from other groups that were trying to build houses that the financing is always the weakest point in the whole system, so when we organised ourselves we were founding a kind of enterprise'* Jörg Meyerhoff - (Lynch, 2011b)

He also explained that while the project was part financed by the residents themselves who each put in one third of the cost of their own flats, the other two thirds of the project were financed through borrowing from two different banks. These banks were the GLS bank (Gemeinschaftsbank für Leihen und Schenken) a German ethical bank that funds

environmental building projects and secondly the KfW (Kreditanstalt für Wiederaufbau) which is a German state bank that was founded as part of the Martial Plan after World War 11 to finance the redevelopment of Germany .

It now offers low interest rate loans to redevelopment and environmental projects throughout Germany.

> *'We had one bank for the whole house, for the whole project, that was GLS bank, a bank specialised on ökologische projects and they would give part of the credits and another part was Kreditanstalt für Wiederaufbau KfW, which is a public bank and they give very cheap credit for people who build energy saving houses'* Jörg Meyerhoff - (Lynch, 2011b)

Jörg explained that the residents were responsible for running the flats themselves and that they divided themselves into specific management groups which looked after different aspects of the day to day management of the building, the plant room and services. The building includes a cellar plant-room and bicycle storage, a communal garden and a ground floor communal meeting room that can be used for various events.

While some initial teething problems were experienced through both the evolution of the housing association community and the development and running of the building, most of these problems were solved during the first year of operation.

Some key issues were highlighted in relation to the overall services and ventilation strategy for this building which uses centralised plant systems such as a wood-pellet boiler for water heating and top-up space heating grey-water harvesting which are housed in the cellar and a central MVHR unit which is housed on the sixth floor. Some residents initially had problems understanding how the grey-water recycling system worked and were irritated when it started to smell of perfumes from shampoo and bubble baths and one resident reported noise issues in relation to the MVHR installation in their flat. More significantly since the house is designed as one system, residents had to learn that they could not individually leave windows open in their own flats for long periods of time during the heating season or switch the heating off in their own flats for long periods without potentially adversely affecting the comfort of other residents. The residents had to learn to

co-operate to manage the thermal comfort in the building, but once this was understood it caused no problems.

The KlimaSolarHaus backs onto a school and the residents remarked that they were happy with the sound insulation that the building fabric provided against the noise from the school and general external street noise. Jörg did however draw attention to a particular occasion when a crime was committed in the park to the front of the building during the night. A police helicopter was brought in to search for the suspect, this woke most of the rest of the neighbourhood but none of the residents of the KlimaSolarHaus were woken or disturbed by the helicopter.

Conclusions

As is the case for the St.Jakob development, the KlimaSolarHaus project used techniques to develop a community of residents who bought into the project as a community from the earliest design phases onwards. Each resident was allowed input into the management process and to have influence over the final design of their individual flats, the building as a whole and the operational strategies.

The residents of KlimaSolarHaus also bought into a contractual agreement to buy and run their flats as a community or housing association.

A key difference between the St.Jakob project and the KlimaSolarHaus is the fact that the KlimaSolarHaus is designed around centralised building services and MVHR system. The KlimaSolarHaus also makes more use of on-site renewable energy technologies such as solar thermal and wood pellet heating to support the domestic hot water and top-up space heating. These flats also use grey-water harvesting but do not have a green roof like at St.Jakob.

The residents of the KlimaSolarHaus gave similar feedback to the residents of the St.Jakob development in relation to their overall satisfaction with the project specifically in relation to the cost of heating overall comfort was also similar with the exception of dry indoor air quality being reported by two residents of the St.Jakob project. Since none of the flats in the KlimaSolarHaus development was a maisonette there were no similar problems as were mentioned by Thomas and Melanie from the St.Jakob development in relation to noise travelling down or up an open stairwell. One resident of the KlimaSolarHaus did however

complain about the noise associated with the ventilation system in her flat, but this did not seem to be a problem in the flats of other residents who were interviewed. The acoustic design nature of the building, which means it is very 'noise impermeable' or sealed could potentially offer advantages especially in a noisy built up city environment. It may however also prove uncomfortable for some residents who are used to hearing the sounds of busy streets and wildlife and who wish for a stronger acoustic connection with the outside world.

A key difference between the two developments is in the maintenance regimes. While some communal facilities are part-maintained by residents of St. Jakob, such as the green roof, individual comfort and maintenance of the MVHR units in the individual flats in St. Jakob is the responsibility of those occupying the flats, whereas the main building services and MVHR in the KlimaSolarHaus are run and maintained by resident groups in the house. Both developments do however use the services of external contractors to support the maintenance regimes and there are still links to members of the design team inclusive of the architect and the building services engineer.

Summary of Key Points

The two Passivhaus blocks of flats are located in different regions within Germany with different local climates, showing it is possible to build to the Passivhaus standard in these two different regions. The occupant feedback from both of these developments indicates general levels of satisfaction with comfort in summer and winter for each development but some issues in relation to dry indoor air quality was reported in the St. Jakob development and noise from the MVHR system in the KlimaSolarHaus.

The occupants of both developments have indicated that they had to learn how to maintain indoor thermal comfort levels in summer and winter by successfully employing the use of the MVHR systems and principles for controlling natural ventilation such as appropriate window opening strategies and the use of shading devices which form part of the building designs.

These projects demonstrate two different approaches to designing and living in a Passivhaus, one with individual MVHR units in dwellings and one with central building services and MVHR systems. Both of these approaches, according to this occupant feedback, seem to be generally successful. This shows that it is possible to design dwellings to the

Passivhaus standard using different building services design strategies and different operational/management regimes, but that a centralised system for flats would take a greater understanding and co-operation of residents to function well.

Specific community building techniques were employed in the case of both developments with the aim of creating cohesion between tenants during design, construction and occupation of the buildings. The community building exercises were also used to inform residents about the requirements of living in a Passivhaus. The main success of both these two developments can be attributed to the willingness of residents to buy into and participate in the design and management of the projects. Thus they developed a vested interest in making their building and community work. All the residents who were interviewed bought into the developments for a longer rather than shorter time-frame, so they bought the flats as homes, as a family, an individual or for retirement and not purely as an investment.

The residents of both developments had to learn new behaviours to enable the successful functioning of these Passivhaus projects, but these were not seen to been difficult or restrictive. Once the residents learnt how to operate or work with the systems the systems did not appear to adversely impact upon their lives.

All the residents of both projects who were interviewed were generally happy with the comfort levels and low heating bills but there were some issues with dry indoor air quality. The residents were also happy with the sense of community that had developed as part of their projects. Some issues did arise in relation to noise from MVHR and the sealed acoustic nature of the environment in the KlimaSolarHaus with all the windows closed. It was issues that related to the acoustic design that some of the residents would change for future projects.

The affordability and financing of the projects were important factors contributing to the success of these developments as was direct and indirect support from local and national government. It was also important that those who were employed to design and construct the buildings had prior experience with designing or building to the Passivhaus standard.

The overall success of these Passivhaus buildings has been contingent on a combination of successful installation of technology combined with financial and social support and buy-in.

Comparison between UK and German Case Studies

The following table compares key findings from all the case studies reviewed for this chapter.

Figure 35 Table of Comparison between UK and German Case Studies

		Project Name				
No.	Item	Canolfan Hydden	Larch House	Denby Dale	St.Jakob's	Klimasolarhaus
1	*Location*	Machynlleth, Wales	Ebbw Vale, Wales	Denby Dale, Yorkshire	Frankfurt	Berlin
2	*Urban/Rural*	Rural - small town	Rural - new town	Rural - small town	Urban - city center	Urban - city center
3	*Client*	Powys County Council	United Welsh Housing Association + WAG	Private	Frankfurter Aufbau AG	Klimasolarhaus Berlin GbR
4	*Size sq.m*	410 sq m	100 sq m	118 sq m	1927 sq m	2130 sq m
5	*Build Cost*	£1537 /sq m	£1700 /sq m	£1194 /sq m	€1100 /sq m	€1475 /sq m
6	*Funding*	PCC + WAG	BGCB + WAG	Private	Private	KfW, GLS Bank + Private
7	*Occupancy type*	Public Community Centre	Social housing tenants	Private owner occupier	Owner through RSL but private owners	Private housing community/association
8	*Design Team*	Local Welsh + AECB	London	Local Yorkshire + AECB	Not local experienced PH designers	Not local experienced PH designers
9	*Contractors*	Local Welsh	Local Welsh	Local Yorkshire	Not local experienced PH contractors	Not local experienced PH contractors
10	*Construction Type*	Timber frame	Timber frame	Cavity wall construction	Mixed construction Concrete frame	Mixed construction Concrete frame
11	*Design Performance*	15kWh sq m + 120 kWh sq m primary energy	13kWh sq m + 83 kWh sq m primary energy	15kWh sq m + 87 kWh sq m primary energy	12.8 kWh sq.m + 15.8 kWh sq. m + Primary Energy 120 kWh. SqM	8kWh sq m + 42 kWh/sq m primary energy
12	*Built Performance*	Better as predicted	No information yet	As predicted	Better as predicted	No information yet
13	*MVHR zones*	Central system	One	One	Individual flats as one zone each - individual MVHR	Central system
14	*Air-permeability tested*	0.249-1@50 pa	0.2-1@50 pa	0.33-1@50 pa	0.33-1@50 pa * each flat tested separately	0.4-1@50 pa
15	*MVHR*	Central system	One central system	One central system	One in each flat	Central system
16	*Additional Systems e.g. renewable energy technologies*	PVs	PVs	Solar thermal	no renewable energy systems	Wood pellet boiler + solar thermal + grey-water recycling
17	*Supply Chain*	key EU imports - such as MVHR and windows	key EU imports such as MVHR and windows	key EU imports such as MVHR and windows	German/EU	German/EU
18	*Other Facilities*	Remote PVs + green roof	N/A	N/A	Bike stores, storage + garden + green roof	Bike store, community garden + meeting space
19	*Occupant Satisfaction*	Good - a degree of learning associated with systems	No current feedback	Good - had to learn to live there	Good - had to learn to live there	Good - had to learn to live there
20	*Key Issues*	Bringing in German and Austrian design components at extra expense - working with existing LA procurements systems and UK procurement structure as a whole - Designing with Parrt F + BREEAM Excellent	Bringing in German and Austrian design components + bringing in German training for compent installations such as windows - designing to CSH 6	Bringing in German and Austrian design components at extra expense - working with existing planning UK systems - CSH/Passivhaus contradictions - Occupants learning to live in house	Occupants learning to live in the development with new types of technologies - some issues with dry indoor air quality and cost of maintenance of MVHR + acoustics	Occupants learning to live in the development with new types of technologies - Central system for so many flats - grey water recycling and wood pellet boiler + communications and skills during design and construction - some issues with acoustic properties of building and that of MVHR installation - Also issues surrounding learning to operate building with central MVHR system

Please see appendices for larger table of Figure 35.

The three UK case studies are all some of the earliest accredited Passivhaus buildings in the UK. Two are residential with one of these being a private dwelling and the other part of a

social housing project, the third case study is a small community centre. In contrast both the German case studies are blocks of flats and are privately owned but have been procured in conjunction with different types of housing association or community housing group.

Although the German projects have been built in a country where the Passivhaus standard is better developed than in the UK, both these two projects can be seen as being 'experimental' within this context. The St. Jakob project in Frankfurt was the first block of flats built to the Passivhaus standard in Germany; it is also predominantly north facing and therefore of special interest in relation to its design and overall energy performance and use of solar gain, which makes up a component part of the energy design of a Passivhaus and since maximum solar gain experienced in the northern hemisphere is from the south and west facades of a building.

The KlimaSolarHaus is unusual in being one of the first Passivhaus buildings to be completed in Berlin. Both the German projects are also particular because of their procurement methods which involved the participation of occupants from the very earliest stages of the project prior to procurement of the sites and during design, construction and final operation of the buildings. This has helped to ensure occupant's 'buy-in' and smooth operation for the projects and gave the occupants a good understanding of the Passivhaus concept and what it means to live in one prior to them occupying their homes.

All the projects with the exception of the Larch House (where the tenants have not been directly involved with the design of the house and have chosen to live there as part of a competition) utilised a high degree of 'buy-in' from clients or occupants as compared to processes surrounding the procurement of most conventional buildings.

In all cases great care was taken to manage design, construction and occupation processes to ensure success of the developments.

Cost

The build cost for the Canolfan Hyddgen community centre in Machynlleth were found to be directly comparable to a similar sized school building designed only to meet the requirements of BREEAM Excellent, but not the Passivhaus standard in combination with BREEAM Excellent. The build costs for both the Larch and Lime houses was found to be higher than a typical UK build project, as were the costs for Denby Dale house. This cost uplift was found to be approximately 10-15% above standard costs for conventional UK housing projects. These additional costs have however been attributed to the prototype nature of the projects and additional learning curves associated with their delivery. They also reflect the early stage development of this innovation and perhaps the additional care required to build to this standard, particularly when considering site skills and monitoring requirements. In conjunction with this many of the key components used in the construction for both these developments, such as windows and MVHR units were imported from mainland Europe thus introducing additional cost which would not necessarily be incurred with the use of indigenous UK products, through transport costs.

The German developments were delivered at similar cost to conventional flats in Germany, but in both cases the projects had the advantage of cheap or cost free land on which to build. In the case of the KlimaSolarHaus in Berlin, this development was also supported with a cheap loan from the KfW German state bank. This is of great significance when understanding final overall costs for the projects, which would have been higher without 'subsidised 'land costs and finance.

If the projects were to be reviewed in terms of whole life costs, therefore taking account of the reduction in heating and energy bills throughout the life of the project against capital build costs, all the projects would then potentially start to appear more affordable. This would need to be examined as part of further research.

If these buildings were constructed as part of a speculative market and being sold on to new owners then the lower running cost savings associated with the Passivhaus design may not appear so attractive to a developer, who would not be responsible for these costs.

While the KlimaSolarHaus received support with a low interest loan from the KfW bank the Frankfurt and UK projects received no such similar financial support, with no similar mechanism currently in existence in the UK, at the time of this research.

Procurement

All the UK projects were procured under mechanisms which allowed for a high degree of architect and engineer intervention on site, especially in relation to issues surrounding quality control of construction. With different procurement methods such as 'Design and Build' contracts which are commonly used in the UK, this level of control is not always a possibility, since responsibility for QA is often distributed between designers and contractors. This type of process could be detrimental to achieving the level of detail control in construction necessary to deliver a Passivhaus standard building, but would have to be tested as part of further research.

In the case of the German projects, the St.Jakob development was built by experienced Passivhaus architects and designers who had previously been involved with the design of some of the earliest Passivhaus buildings in Germany. This experience undoubtedly helped them to understand many of the pitfalls associated with designing and building a Passivhaus and for them to deliver a better quality product.

In the case of the KlimaSolarHaus in Berlin, the original Berlin architects originally appointed as part of the project team, were eventually replaced by architects from Hamburg with more experience in the realm of Passivhaus design and project delivery than their Berlin conunterparts.

Construction

Both the Canolfan Hyddgen and the Larch house were built using timber frame construction whereas the Denby Dale Passivhaus was built using the more traditional UK construction method of cavity wall construction. Both these construction types were found viable to meet the requirements of the Passivhaus standard in the UK.

The German developments were constructed using a concrete frame which is more typical for housing developments in Germany.

The representation of different construction types in the case studies indicates how the Passivhaus standard can be appropriate for different methods of construction.

Performance

Performance figures from monitoring the operation of the Canolfan Hyddgen, the Denby Dale Passivhaus and the St. Jakob development all show these buildings to perform as well as or better than design intentions in terms of energy use. Figures from the Larch House and KlimaSolarHaus are still to be reviewed since full monitoring of both project is (at the time of this research), to be completed.

Feedback from the interviews with the residents of the KlimaSolarHaus has indicated that areas where operational performance may not have met with initial design expectations are linked to subsidiary technologies such as the grey-water recycling and the use of the wood pellet boiler, both of which have been mentioned as presenting some problems by occupants. Likewise living with only one central MVHR system in the KlimaSolarHaus seems to have presented more of a challenging learning curve for the occupants than the use of individual MVHR units, which have been employed for all the other residential projects. The challenges have also involved residents of the St.Jakob's and the KlimaSolarHaus projects having to get used to the acoustically sealed environment in a Passivhaus. In conjunction to this one resident from the KlimaSolarHaus reported some problems with noise from the MVHR installation.

Occupant Satisfaction

With the exception of the Larch House, which was only occupied at the end stage of this research, both the other UK projects and the two German projects seem to initially show a high level of occupant satisfaction. It is however clear from both the Denby Dale occupant blog and the feedback from the interviews with the residents of the German projects, that occupants have had to learn to live in their new dwellings and understand how to interact with the new technologies and designs. This has included for a better understanding of overall operations in their dwellings so that they can achieve optimum thermal comfort, but also the need to become acclimatised to an acoustically very sealed environment.

Summary

Despite these projects being of different construction types and built in different countries with varied local climates, it appears that the Passivhaus standard can be appropriate and function in all these situations.

These projects are all ‘pioneer’ projects and have involved high levels of ‘buy-in’ from designers, contractors and occupants for successful delivery. They have also involved the need for occupants to specifically learn to live with their new types of built environment.

Additional costs have been shown to be associated with the learning curves surrounding the delivery of early or ‘first-time’ Passivhaus developments. It is however possible that these costs could be reduced over time once construction techniques and new skills have been mastered. Costs could also be offset over time through reduced heating and energy bills, if projects are reviewed in relation to whole life costs.

For all projects attention to detail of design and delivery has shown to be a key factor in their success.

Results and Discussion

Introduction

The aim of this chapter is to present the findings from the Q-analysis, interpret these results and compare them with the findings from the case studies, thus bringing the component parts of this research together for review, cross-reference or triangulation.

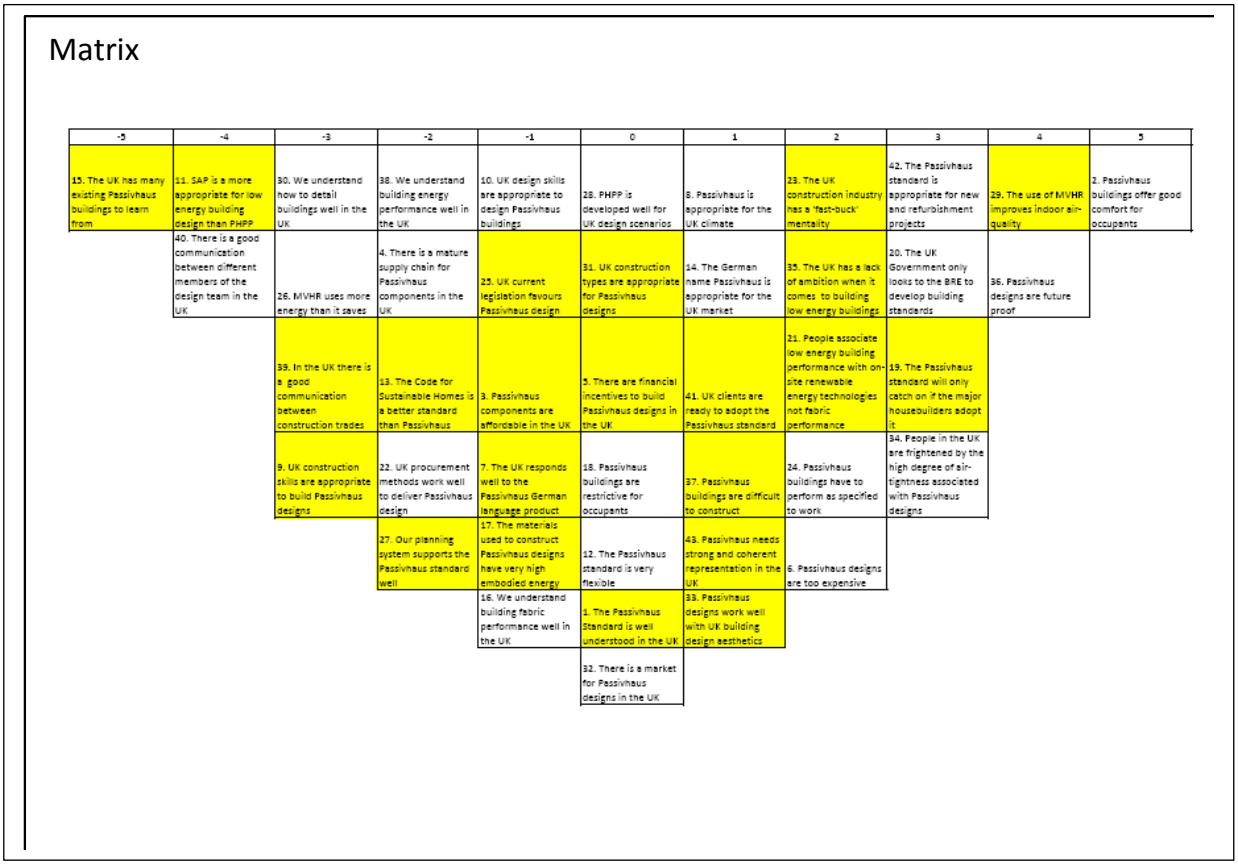
This chapter starts with a description of the Q-methodology process (Q-Tests) and documentation of the results of the tests.

Q-Tests

The Q-tests were administered to individual respondents in their work places or in a private room at UCL (University College London), according to the respondent preference. For each Q-test the respondent was provided with the same set of the final concourse statements or Q-sample (as included in the methodology chapter). This set of statements was provided on un-numbered cards with one statement on each. The respondents were then asked to 'sort' the statements according to preference on a pre-defined paper matrix, weighting each statement in accordance with how much they agreed or disagreed with it. See sample below. (Figure 36).

Figure 36 - An example of a completed Q-test matrix

N.B the statements on this matrix have been numbered as part of the Q-analysis process but were not numbered during the actual tests



Of the 45 respondents who undertook the Q-test, 35 agreed to provide interviews and agreed that quotations and transcriptions from these interviews could be included as part of this research. All transcriptions and quotations have however been made anonymous, as also agreed with the respondents. The table below (Figure 37) is also included in the appendices as are the transcriptions.

Figure 37 - Table of stakeholders included in the Q-tests and Interviews

Q-test Respondents – Alphabetical List

No.	Interview Code	Professional Description	Q-test	Interview Transcription
1	A	Passivhaus Consultant	yes	yes
2	B	Engineer/Independent Passivhaus Consultant and Trainer	yes	yes
3	C	Passivhaus Consultant	yes	no permission given to use interview
4	D	Passivhaus Consultant and Architect	yes	yes
5	E	Architect/Certified Passivhaus Designer	yes	yes
6	F	Architect/ Designer of early UK Passivhaus Refurbishment	yes	yes
7	G	Architect and Passivhaus Designer of early UK New-build Passivhaus Projects in UK	yes	no – did not give interview
8	H	Architect and Passivhaus Designer	yes	no – did not give interview
9	I	Architect and Passivhaus Designer	yes	no – did not give interview
10	J	Architect and Passivhaus Designer	yes	no – did not give interview
11	K	Architect and Passivhaus Designer	yes	yes
12	L	Architect and Passivhaus Designer	yes	yes
13	M	Architect and Passivhaus Designer	yes	yes
14	N	Architect and Passivhaus Designer	yes	yes
15	O	Architect and Passivhaus Designer	yes	yes
16	P	Architect and Passivhaus Designer	yes	yes
17	Q	Sustainable Design Engineer	yes	yes
18	R	Sustainability Consultant	yes	no – did not give interview
19	S	Sustainability Consultant	yes	yes
20	T	Building Services Engineer	yes	yes
21	U	Engineer	yes	yes
22	V	Engineer	yes	yes
23	W	Engineer/ Passivhaus designer	yes	yes
24	X	Engineer	yes	yes
25	Y	Engineer	yes	yes
26	Z	Passivhaus Client	yes	yes
27	AA	Passivhaus Client /Passivhaus Designer	yes	yes
28	BB	Passivhaus Client	yes	yes
29	CC	Engineer/Higher Education Lecturer	yes	no – did not give interview
30	DD	Architect/Higher Education Lecturer	yes	no – did not give interview

31	EE	Architect/Higher Education Lecturer in Passivhaus Design	yes	yes
32	FF	Higher Education Lecturer/Architect	yes	yes
33	GG	Higher Education Lecturer/Physicist	yes	yes
34	HH	CSH/Sustainability consultant	yes	no permission given to use interview
35	II	CSH and Passivhaus Consultant	yes	yes
36	JJ	Passivhaus Contractor	yes	yes
37	KK	Passivhaus Contractor	yes	yes
38	LL	London Planner	yes	no – did not give interview
39	MM	London Planner	yes	yes
40	NN	London Planner	yes	yes
41	OO	London Planner	yes	yes
42	PP	Policy Advisor	yes	yes
43	QQ	Policy Advisor	yes	yes
44	RR	Policy Advisor	yes	yes
45	SS	Policy Advisor	yes	yes

Analysis

Matrices of opinions produced by stakeholders were analysed using PQ software with the following results. The table below (Figure 38) shows concourse statements from the Q-test against five factors. Each statement has been weighted from -5 to +5 within the factors. These weightings correspond to positive, neutral or negative group opinion about the statement.

Figure 38 - Table of Concourse Statements and Q-Factors

	Concourse Statement	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	The Passivhaus standard is well understood in the UK	-2	-2	-4	-4	-3
2	Passivhaus buildings offer good comfort for occupants	5	5	3	4	3
3	Passivhaus components are affordable in the UK	0	-1	-1	-2	-2
4	There is a mature supply chain for Passivhaus components in the UK	-3	-4	-3	-3	-3
5	There are financial incentives to build Passivhaus designs in the UK	0	-2	-2	-2	-4
6	Passivhaus designs are too expensive	0	0	-1	1	-1
7	The UK responds well to the Passivhaus German Language product	-1	-3	-1	-1	-3
8	Passivhaus is appropriate for the UK climate	4	2	2	2	2
9	UK construction skills are appropriate to build Passivhaus designs	-1	1	0	-5	-2
10	UK design skills are appropriate to design Passivhaus buildings	-1	0	1	-1	0
11	SAP is a more appropriate software for low energy building design than PHPP	-5	-1	-3	-2	-3
12	The Passivhaus standard is very flexible	2	-2	2	0	1
13	The Code for Sustainable Homes is a better standard than Passivhaus	-3	0	-2	-1	-5
14	The German name Passivhaus is appropriate for the UK market	1	-2	0	2	0
15	The UK has many existing Passivhaus buildings to learn from	-2	-5	-3	-4	-4
16	We understand building fabric performance well in the UK	-4	2	0	-1	-1
17	The materials used to construct Passivhaus designs have very high embodied energy	-2	0	0	0	0
18	Passivhaus buildings are restrictive for occupants	-2	-3	-2	0	-1
19	The Passivhaus standard will only catch on if the major housebuilders adopt it	1	1	3	2	3
20	The UK Government only looks to institutions such as BRE to develop building standards	1	-1	1	0	2
21	People associate low energy building performance with on-site renewable energy technologies not fabric performance	2	1	3	3	4
22	UK procurement methods work well to deliver Passivhaus designs	-1	-2	-2	-3	-2
23	The UK construction industry has a 'fast buck' mentality	2	1	5	4	3
24	Passivhaus buildings have to perform as specified to work	2	4	2	3	2
25	UK current legislation favours Passivhaus design	-2	-3	-4	-1	-2
26	MVHR uses more energy than it saves	-4	0	-3	-1	-2
27	Our planning system supports the Passivhaus standard well	-1	0	-5	-2	-1
28	PHPP is developed well for UK design scenarios	1	-1	1	1	1
29	The use of MVHR improves indoor air-quality	4	2	2	1	1
30	We understand how to detail buildings well in the UK	-3	3	0	-3	-1
31	UK construction types are appropriate for Passivhaus designs	0	-3	0	0	1
32	There is a market for Passivhaus designs in the UK	2	3	2	2	1
33	Passivhaus designs work well with UK building design aesthetics	1	1	1	1	1
34	People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	3	-1	1	3	4
35	The UK has a lack of ambition when it comes to building low energy buildings	1	-4	4	1	2
36	Passivhaus designs are future proof	3	3	3	2	2
37	Passivhaus buildings are difficult to construct	0	0	-1	1	0
38	We understand building energy performance well in the UK	-3	4	-1	0	0
39	In the UK there is a good communication between construction trades	-1	1	-2	-3	-1
40	There is good communication between different members of the design team in the UK	0	2	0	-2	0
41	UK clients are ready to adopt the Passivhaus standard	0	-1	-1	0	0
42	The Passivhaus standard is appropriate for new and refurbishment projects	3	2	1	3	3
43	Passivhaus needs strong and coherent representation in the UK	3	3	4	5	5

The table below (Figure 39) shows the concourse statements used as the Q-sample in the tests and the five key factors of opinion that were generated from the assessment of the combined Q-sorts. Each factor of opinion represents a combination of statements that are grouped according to strong agreement or disagreement. The statements most agreed with are highlighted in red and those most disagreed with in dark blue. Pink and light blue colours indicate statements that are relatively less strongly agreed and disagreed with respectively.

Figure 39 - Table Showing Key Factor Weightings

	Concourse Statement	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	The Passivhaus standard is well understood in the UK	-2	-2	-4	-4	-3
2	Passivhaus buildings offer good comfort for occupants	5	5	3	4	3
3	Passivhaus components are affordable in the UK	0	-1	-1	-2	-2
4	There is a mature supply chain for Passivhaus components in the UK	-3	-4	-3	-3	-3
5	There are financial incentives to build Passivhaus designs in the UK	0	-2	-2	-2	-4
6	Passivhaus designs are too expensive	0	0	-1	1	-1
7	The UK responds well to the Passivhaus German Language product	-1	-3	-1	-1	-3
8	Passivhaus is appropriate for the UK climate	4	2	2	2	2
9	UK construction skills are appropriate to build Passivhaus designs	-1	1	0	-5	-2
10	UK design skills are appropriate to design Passivhaus buildings	-1	0	1	-1	0
11	SAP is a more appropriate software for low energy building design than PHPP	-5	-1	-3	-2	-3
12	The Passivhaus standard is very flexible	2	-2	2	0	1
13	The Code for Sustainable Homes is a better standard than Passivhaus	-3	0	-2	-1	-5
14	The German name Passivhaus is appropriate for the UK market	1	-2	0	2	0
15	The UK has many existing Passivhaus buildings to learn from	-2	-5	-3	-4	-4
16	We understand building fabric performance well in the UK	-4	2	0	-1	-1
17	The materials used to construct Passivhaus designs have very high embodied energy	-2	0	0	0	0
18	Passivhaus buildings are restrictive for occupants	-2	-3	-2	0	-1
19	The Passivhaus standard will only catch on if the major housebuilders adopt it	1	1	3	2	3
20	The UK Government only looks to institutions such as BRE to develop building standards	1	-1	1	0	2
21	People associate low energy building performance with on-site renewable energy technologies not fabric performance	2	1	3	3	4
22	UK procurement methods work well to deliver Passivhaus designs	-1	-2	-2	-3	-2
23	The UK construction industry has a 'fast buck' mentality	2	1	5	4	3
24	Passivhaus buildings have to perform as specified to work	2	4	2	3	2
25	UK current legislation favours Passivhaus design	-2	-3	-4	-1	-2
26	MVHR uses more energy than it saves	-4	0	-3	-1	-2
27	Our planning system supports the Passivhaus standard well	-1	0	-5	-2	-1
28	PHPP is developed well for UK design scenarios	1	-1	1	1	1
29	The use of MVHR improves indoor air-quality	4	2	2	1	1
30	We understand how to detail buildings well in the UK	-3	3	0	-3	-1
31	UK construction types are appropriate for Passivhaus designs	0	-3	0	0	1
32	There is a market for Passivhaus designs in the UK	2	3	2	2	1
33	Passivhaus designs work well with UK building design aesthetics	1	1	1	1	1
34	People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	3	-1	1	3	4
35	The UK has a lack of ambition when it comes to building low energy buildings	1	-4	4	1	2
36	Passivhaus designs are future proof	3	3	3	2	2
37	Passivhaus buildings are difficult to construct	0	0	-1	1	0
38	We understand building energy performance well in the UK	-3	4	-1	0	0
39	In the UK there is a good communication between construction trades	-1	1	-2	-3	-1
40	There is good communication between different members of the design team in the UK	0	2	0	-2	0
41	UK clients are ready to adopt the Passivhaus standard	0	-1	-1	0	0
42	The Passivhaus standard is appropriate for new and refurbishment projects	3	2	1	3	3
43	Passivhaus needs strong and coherent representation in the UK	3	3	4	5	5

Summary of Factors

The following table isolates the statements from each of the five factors that were most agreed or disagreed with. These statements provide the basis or key opinions for each factor and represent the strongest opinions from the group. They are then used as the basis for descriptive titles for each of the five factors listed below.

Figure 40 - Table of Key Factors of Opinion

	++	+		-	--
1	Passivhaus offers good comfort for occupants	Passivhaus is appropriate for the UK climate The use of MVHR improves indoor air-quality		We understand building fabric performance well in the UK MVHR uses more energy than it saves	SAP is a more appropriate software for low energy building design than PHPP
2	Passivhaus buildings offer good comfort for occupants	Passivhaus buildings have to perform as specified to work We understand building energy performance well in the UK		There is a mature supply chain for Passivhaus components The UK has a lack of ambition when it comes to building low energy buildings	The UK has many existing Passivhaus buildings to learn from
3	The UK industry has a 'fast-buck' mentality	Passivhaus needs strong and coherent representation in the UK The UK has a lack of ambition when it comes to building low energy buildings		The Passivhaus standard is well understood in the UK UK current legislation favours Passivhaus design	Our planning system supports the Passivhaus standard well
4	Passivhaus needs strong and coherent representation in the UK	Passivhaus buildings offer good comfort for occupants The UK industry has a 'fast-buck' mentality		The Passivhaus standard is well understood in the UK The UK has many existing Passivhaus buildings to learn from	UK construction skills are appropriate to build Passivhaus designs
5	Passivhaus needs strong and coherent representation in the UK	People associate low energy building performance with on-site renewable energy technologies not fabric performance People in the UK are frightened by the high degree of air-tightness associated with Passivhaus buildings		There are financial incentives to build Passivhaus designs in the UK The UK has many existing Passivhaus buildings to learn from	The Code for Sustainable Homes is a better standard than Passivhaus

Descriptive title for each of the five factors of opinion – these titles summarise the key points from each factor of opinion -

- Comfort, Climate, MVHR and SAP
- Comfort, Energy Performance, Supply Chain, Ambition and Precedent
- Short-Termism ('fast-buck' mentality) , Representation, Ambition, Legislation and Planning
- Representation ,Comfort, 'Fast-buck' Mentality, Precedent and Skills
- Representation, Energy Performance, Fear of Low Air-Permeability, Financial Incentives, Precedent and Policy

These factors have then be interpreted as follows -

Interpretation of Factors

The essence to understanding the factors is their interpretation. Each of the five factors of opinion have been reviewed and interpreted with weightings placed on the statements that were most and least agreed with. In each case representative quotations from individual stakeholder interviews, gathered during the Q-tests, have been used to demonstrate further depth of opinion. The factor interpretation is then followed by a summary.

Factor One – Comfort, Climate, MVHR and SAP

Most agreed with	Second most agreed with	Second least agreed with	Least agreed with
(2)*Passivhaus offers good comfort for occupants	(8)Passivhaus is appropriate for the UK climate (29)The use of MVHR improves indoor air-quality	(26)MVHR uses more energy than it saves (38)We understand building fabric performance well in the UK	(11)SAP is a more appropriate software for low energy building design than PHPP

*- number in brackets () relates to statement number from the table of concourse statements

The statement most agreed with for this factor was – that ***'(2)Passivhaus offers good comfort for occupants'***, and the statement least agreed with was that ***'(11)SAP is a more appropriate software for low energy building design than PHPP***'.

The statements that gained the second highest levels of agreement were that - **'(8)*Passivhaus is appropriate for the UK climate***' and that ***'(29)The use of MVHR improves indoor air-quality***'. The statements that met with the second highest level of disagreement were that ***'(26)MVHR uses more energy than it saves***' and ***'(38)We understand building fabric performance well in the UK***'.

The overall summary of weightings of opinion for these statements shows a bias in concern for issues relating to comfort, ventilation, building energy performance, indoor air-quality using MVHR and the current UK building energy design software for domestic buildings, SAP.

Comfort

Of significance with this first factor of opinion is that opinion is heavily weighted on the issue of good occupant comfort.

There is a body of research literature which has been produced by the German Passivhaus Institut in Darmstadt and others which relates to Passivhaus performance inclusive of comfort and indoor air-quality. This is largely based on evidence acquired from monitored Passivhaus buildings in Germany and the wider EU. This literature concludes that Passivhaus buildings have the capacity to offer a high degree of occupant comfort and good indoor air-quality, but may have the potential to produce a dry indoor air-quality, as described in the series of '*Protokollband*' reports produced by the Passivhaus Institut in Darmstadt (PHI) such as Protokollband Nr.23 – '*Einfluss der Lüftungsstrategie auf die Schadstoffkonzentration und –ausbreitung im Raum'* (Feist et al., 2003) (*'The influence of ventilation strategy and pollutant concentration on internal indoor air-quality*')and '*Sparsames Wäschetrocknen'*(Feist, 1998a) *(Efficient Washing Drying)* as a result of air being dried through the heat exchanger in the MVHR unit during the ventilation process. The report, Protokollband Nr.23 contains ten papers on different themes surrounding ventilation in a Passivhaus, such as the impact of indoor air quality on hygiene and recommendations for ventilation strategies in Passivhaus designs. The conclusions of these papers are generally favourable concerning the performance of Passivhaus buildings in relation to indoor air-quality. They also show that Passivhaus buildings perform better than equivalent naturally ventilated buildings in terms of all internal pollutant levels such as CO_2 (Carbon Dioxide). This literature is only available in German, so it would be difficult for the Q stakeholders or those outside of German speaking countries to access this material directly. In the case of Q Respondents it is likely that their opinions surrounding the issue of comfort in a Passivhaus are obtained from other sources of information.

When considering comfort in terms of thermal comfort the design of a Passivhaus aims to create an even indoor air temperature of between 17 – 21˚C all around the year, however the potential for a Passivhaus building to overheat on exceptionally hot days in summer has sometimes been questioned. In their paper titled '*Overheating in Residential Passive House: Solution Strategies revealed and confirmed through data analysis and simulations*' (Mlkakar and Strancar, 2011) published in Energy and Buildings in 2011, Jana Mlkakar and Janez Štrancar examine issues of overheating and offer solutions through the use of night-cooling and natural ventilation strategies which are confirmed as appropriate mitigational strategies. These types of solutions have been shown to have the potential to deliver

summer comfort on very hot days. Findings from the POE interviews with residents of the St.Jakob's development in Frankfurt and the KlimaSolarHaus in Berlin provide some supporting evidence that summer overheating can be successfully controlled through resident interaction with the building operation, for example through the appropriate use of summer shading. Feedback from these brief occupant surveys however shows some evidence that the developments may have a 'dry' indoor air-quality and that the occupants of a Passivhaus may have to learn to live with its specific acoustics, which can work to block out external sound. The MVHR installation may also present some noise issues, depending upon its installation. Issues relating to noise from MVHR installations and occupant comfort have also been reported in recent post-occupancy evaluation studies from domestic buildings in the Netherlands (van der Pluijm, 2010)

Climate

A strongly positively weighted statement from this factor which can also be linked to the statement about SAP and PHPP was the statement '***Passivhaus is appropriate for the UK climate'***. An issue was however noted by the stakeholder group about the lack of inclusion of enough accurate UK weather data as part of PHPP. This issue is also remarked upon by Peter Warm, the certifier of many UK Passivhaus projects, on the Passivhaus Institute database of built projects (PHI, 2012a) and referred to in the UK domestic case studies. At the time of these interviews and Q-tests a full set of UK English weather data files was not included as standard within PHPP 2007. Despite this, evidence from recent Passivhaus projects built in the UK such as the Canolfan Hyddgen in Machynlleth and the Denby Dale Passivhaus seem to show that Passivhaus buildings can be appropriate for the UK climate if designed appropriately.

MVHR

Two statements relating to MVHR figure strongly as part of this factor of opinion. They represent respondent opinion but may also be relevant to a wider UK industry understanding of this technology and its specific use as part of heating and ventilation strategies for dwellings. This can also be demonstrated in findings from the case studies and brief history of Passivhaus. Specific stakeholder opinions in relation to MVHR are illustrated with the following statements -

' but I think that the whole notion of understanding what the MVHR does in terms of energy and sound quality is not brilliantly understood – clearly this is something in conjunction with a number of other things – if you put it in (MVHR) to a number of buildings where it doesn't meet the required air-tightness then yes it will (use more energy) as it is just like sucking air in and blowing air out – it is just the wrong piece of kit and I think this is probably something that is not well understood in the British construction industry' - ***M*** **- Architect and Passivhaus Designer**

'It says that MVHR uses more energy than it saves – I don't find that – there are other things that I would have problems with it – like it would break down or get blocked up' - ***GG*** **- Higher Education Lecturer/ Physicist**

'we had a session on ventilation and moisture last week and – it is quite interesting because some of the people came in to the meeting and their view was if we are going to have to get to Code 4 we are going to have to use MVHR anyway – so there won't be a problem with moisture – a complete lack of understanding about the difficulties of making sure that they work operationally – because you expect that people know how to operate them – and expecting low income tenants for example, who have got many other worries to work out and to care about changing filters and making sure that the system is working properly – even if they know how it works and they are taught properly' - ***RR*** **- Policy Advisor**

These statements are also supported by recent findings from research undertaken by Leeds Metropolitan University into housing at Stamford Brook (Wingfield et al., 2007) which concluded that the correct design, installation and commissioning of MVHR and MEV (Mechanical Extract Ventilation), are integral to performance, together with findings from research undertaken by BRE, documented in the report '*Information Paper IP9/08 Part 2 – Applying the Code for Sustainable Homes on the BRE Innovation Park: Lessons learnt about energy sources, overheating and ventilation*'(Gaze et al., 2008). This report states that –

'The installation of ventilation systems and ductwork needs to be considered at the design stage and not left to be resolved on site. If ductwork routing is not adequately considered at the design stage, installation may be difficult and the performance of the system compromised.' (Gaze et al., 2008)

Further research undertaken by Stevenson and Rijal (Stevenson and Rijal, 2008) for Oxford Brookes University into the Sigma House at the BRE Innovation Park argues that installed technologies must also be user friendly if they are to be a success.

Issues relating to the statement about MVHR using more energy than it saves can be examined in the work of Lowe in his paper '*Ventilation Strategy, energy use and CO_2 emissions in dwellings'* (Lowe, 2000) which demonstrates the need for buildings to be constructed to high levels of air-tightness/low air-permeability for MVHR to perform to its optimum in terms of energy efficiency and internal comfort levels. However if fabric performance criteria are satisfied the AECB (AECB, 2008) argue that the use of MVHR will save energy in comparison to a natural ventilation strategy for the same Passivhaus specification dwelling. This is also demonstrated in research from the Passivhaus Institut in Darmstadt who argue that MVHR will use about 10% of the primary electrical energy in a Passivhaus home (Feist, 1998b)

In the quotation from an Engineering Director from UK consultants ARUP from an email dated 10.12.08, when referring to the Lighthouse, at the BRE Innovation Park, for which ARUP were the design engineers and which was built to the CSH Level 6 (or '*zero carbon*' level), it is argued that there may still be a debate surrounding levels of CO_2 emissions from MVHR versus energy use in kWh -

> *'Prior to doing the Kingspan Lighthouse and the Barratt Greenhouse we did a set of parallel calculations, not least because we believe SAP is somewhat simplistic when it comes to solar gain, ventilations, domestic hot water demand, etc.*
>
> *Among the things we found was that in a super-insulated home with very modest space heating demands, the fan power carbon emissions can exceed the heat recovery carbon savings. This was also the case if we used the new generation super-low energy fan units (SFP (SFP<1W/l/s) from Europe. This was particularly the case if it has room exposed thermal mass.*
>
> *Note this is carbon emissions not energy. This is where the grade of energy used (& its carbon content) becomes so important instead of simply the number of kWhs. The*

carbon measure also makes a reasonable approximation for relative operating cost and of the relative capital cost of renewable electricity verses renewable heat.

That said we did not pursue the issue further at that stage for these projects because BRE would not accept alternative compliance routes for CSH6, SAP does not model thermal mass energy influences, and Kingspan wanted to market a MVHR unit without a high thermal mass option! The client is always right……!'* (Twinn, 2008)

This email is reveals a potential need for greater understanding, research and communication surrounding the design, installation and use of MVHR systems by engineers and contractors in the UK. It also demonstrates the potential significance of the influence of the client on the design team and the procurement process and the impact that he or she can have on the final development. Typically the metric of CO_2 emissions or carbon is not used as a standard to assess performance of buildings in Germany or other parts of the EU, where buildings are measured for performance in terms of energy or kWh. This can lead to some confusion over actual environmental impacts of buildings, when assessing them in relation to current UK Building Regulations and CSH criteria. PHPP does however allow for the calculation of CO_2 emissions for a Passivhaus design as separate sheet as part of the software.

Research undertaken by the PHI which is quoted in the brochure *'Active for more comfort: The Passive House*'(PHI, 2009) ,produced by the Passivhaus Institut, states that MVHR has the capacity to –

'save more than 10 times the energy used for their operation' (PHI, 2009)

This is backed up by more in-depth research undertaken by the PHI into ventilation in Passivhaus dwellings in the report *'Luftung im Passivhaus – Passivhaus Bericht Nr. 4'* (Feist, 1997b) and '*Re-inventing air-heating: Convenient and comfortable within the frame of the Passive House concept'* (Feist et al., 2005). This research is again supported by the research of the AECB (AECB, 2008) when comparing CO_2 emissions of MVHR against natural ventilation. Much of the complexity of achieving these energy savings is however discussed in the research undertaken by Lowe (Lowe, 2000) when the need for appropriately low levels of air-permeability are emphasised in order to achieve energy and CO_2 savings.

Fabric Performance

UK understanding of building fabric performance weighted negatively as part of this factor of opinion, showing that the stakeholders did not feel that there was a good understanding of building fabric performance in the UK.

The recent Royal Academy of Engineering (RAE) report '*Engineering a low carbon built environment: The discipline of Building Engineering Physics'* (RAE, 2010) stresses the importance of teaching the discipline of '*Building Engineering Physics'* to those involved in building design if the UK is to deliver a future low carbon built environment –

> '*The need for professionals in the construction industry to be well versed in building engineering physics has never been higher with global concerns to address the sustainability of the built environment. Building engineering physics is a key scientific discipline, the understanding of which allows designers to manipulate the thermal and environmental characteristics of buildings to achieve performance criteria without necessarily relying on energy consuming building services installations.'*(RAE, 2010)

Weight of opinion from this factor could cast some doubt on the competencies of the UK consultancy industry and its ability to understand building fabric design and therefore building physics. A need for a greater understanding of building fabric performance together with building physics seems also to be supported by the RAE report.

PHPP and SAP

The statement relating to SAP being more appropriate for the design of low energy buildings than PHPP is most strongly disagreed with. This is supported with interview data that provides anecdotal evidence that there are current aspects within SAP that mean it is potentially not appropriate for the design of very low energy or Passivhaus buildings. This is despite it being the UK current energy modelling tool for the CSH and Part L energy performance compliance for housing and the specific delivery of CSH Level 6 or '*zero carbon'* homes in the UK. This can be illustrated with the statements from respondent interviews below -

> *'I am not a great believer in our current regulatory model with SAP and DER and TER – that has got such fundamental problems – simply that we know already that*

anomalies such as for some houses you need to increase the heat-loss area to get them through – the current methodology actually penalises good shape – there are loads of problems, I think the whole thing is pretty riddled which is why I work on Passivhaus and not SAP – why I have given up working and teaching on SAP – because I think it is fundamentally flawed and so I don't know what is going to happen in terms of the regulations, I am just keeping on doing something that seems like sanity and why I hope that the Passivhaus approach will gradually filter its way into what we are doing' - ***B*** **- Engineer / Independent Passivhaus Consultant and Trainer**

Some of the stakeholder group considered that PHPP to be a more transparent software than SAP, as represented in the following quotation -

'If something is quite unusual well I say 'can you send me your (PHPP) model and you can go through the model together and you can immediately pick out what they haven't done – the guidance is so fantastic but also you have to understand the principles of what they are doing' - ***EE*** **- Higher Education Lecturer in Passivhaus Design**

However, another stakeholder had doubts about the complexity of PHPP in comparison to SAP and stated -

'*I think there needs to be something in between SAP and PHPP – because PHPP doesn't seem to be very user friendly – and is quite laborious – but SAP doesn't seem to be detailed enough' -* ***Q*****- Sustainable Design Engineer**

Factor One Summary

In summary the significant opinions defining this factor seem to focus on a belief in the capacity for the Passivhaus standard to deliver high levels of indoor comfort, but with doubt being cast on the competencies and understanding from the UK consulting and construction industries to deliver adequate fabric performance and the necessary MVHR design and installation for this to be realised on a consistent basis in the UK. This is in part supported by recent research from the Netherlands. The issues relating to delivery of fabric performance and MVHR installation are also supported by recent academic research undertaken in the

UK by Oxford Brookes and Leeds Metropolitan Universities (cited above) and the of findings from examination of projects at the BRE Innovation Park.

This factor also focuses on the differences between PHPP and SAP and the belief by respondents that SAP is not able to deliver the accuracy of calculation required for very low energy 'Passivhaus ' buildings in the same way that PHPP can, despite some reflection on the difficulty that some designers have had when using PHPP.

Factor Two – Comfort, Energy Performance, Supply Chain, Ambition and Precedent

Most agreed with	Second most agreed with	Second least agreed with	Least agreed with
(2)Passivhaus offers good comfort for occupants	(24)Passivhaus buildings have to perform as specified to work (16)We understand building energy performance well in the UK	(4)There is a mature supply chain for Passivhaus components in the UK (35)The UK has a lack of ambition when it comes to building low energy buildings	(15)The UK has many existing Passivhaus buildings to learn from

The second factor of opinion is represented by the statement that ***'(2)Passivhaus offers good comfort for occupants'*** which is strongly agreed with and that'***(15)The UK has many existing Passivhaus buildings to learn from'*** which is strongly disagreed with.

Following this the most significant statements that were agreed with were that '(***24) Passivhaus buildings have to perform as specified to work***' and that ***'(16)We understand building energy performance well in the UK'***.

The following two statements were significantly disagreed with ***'(4)There is a mature supply chain for Passivhaus components in the UK***' and that ***'(35)The UK has a lack of ambition when it comes to building low energy buildings'***.

Comfort

This factor of opinion believes in the potential for Passivhaus buildings to offer a high degree of occupancy comfort. Some of the issues surrounding Passsivhaus and comfort have been discussed in relation to Factor One, but another issue, supported by the following respondent quotation, is the fact that without available Passivhaus buildings and dwellings for people to visit in the UK, it is difficult for people to imagine and understand the comfort

levels that might be achievable in a Passivhaus and thus compare them to their existing experiences of occupancy comfort -

> *'because I think it is the most misunderstood thing about Passivhaus is that in my view it is a comfort standard primarily – and an energy standard second and that is why it is so good, and that is what we teach and I think that is the thing that people don't get – the problem is also that it is an experiential thing – until you have lived in one, you don't know what people are talking about – more comfortable, 'why what is wrong with my house'? – the fact is you have got draughts and it's freezing and it is too hot and you know – and you think that is good, well you haven't seen anything yet'* – ***B*** **- Engineer / Independent Passivhaus Consultant and Trainer**

The above quotation reflects some of the complexity involved when trying to communicate the experience of living in a Passivhaus to those with no prior experience of living in one. The findings from the German case studies, where occupants mostly find their dwellings very comfortable helps to provide some evidence to verify stakeholder belief in Passivhaus comfort levels, but is likely not to be a substitute for actual experience for the majority of people.

Performance

The statement that '***Passivhaus buildings have to perform as specified to work'*** links to findings from research conducted into the construction and monitoring of the early Passivhaus development at Kranichstein in Germany and results from the CEPHEUS programme. This research concludes that there is a degree of tolerance to which Passivhaus buildings can perform. All the case studies used as part of this thesis demonstrate different variations on designs which all meet the requirements of the Passivhaus standard. Feedback from the two German Passivhaus developments demonstrates that these perform to the design specification requirements but that occupants have had to learn to live with the new technologies associated with the designs. Some comfort and technological 'issues' were reported but these 'issues' were largely been overcome allowing for and the buildings to be very functional.

Supply Chain

This factor of opinion disagrees with the statement that '***There is a mature supply chain for Passivhaus components in the UK'*** this can be supported by the findings from the UK case studies, all of which remark on the lack of indigenous UK manufactured accredited Passivhaus components such as windows, boilers and MVHR systems.

Availability of suitable components and supporting supply chains has also been cited by the PHI in Darmstadt as being an early barrier to the development of the standard in Germany and Austria (IEE, 2006).

The issue of availability of products and supply chain was also highlighted by Gavin Hodgson (formerly of BRE) in his presentation to *the 12th International Conference on Passive Houses in Nuremberg in 2008* (Hodgson, 2008) when he cited these as being some of the main barriers to the uptake of the Passivhaus standard in the UK. From the stakeholder interviews, a policy advisor had the following to say about UK construction industry supply chains in general but with a lack of specific knowledge about this in relation to the Passivhaus standard -

> *'I have talked about components and supplies and supply chains – I think that that is quite important – it is all about systems integration really – things working together – so there is a lot of that that we don't have established really well here, and you find it very difficult to introduce a new product unless it entirely interfaces with all the other products around which already exist, which sort of constrain it to be not particularly innovative in the first place, whereas actually you want a complete system – but how that relates to Passivhaus, I am not really sure – that is a general perspective'* ***– PP –*** **Policy Advisor**

Ambition

The statement '***The UK has a lack of ambition when it comes to building low energy buildings'*** could be supported in the stakeholder interviews by a quotation from a policy advisor who worked with the AECB Carbonlite Programme to develop UK equivalents to the Passivhaus Standard and therefore supports the Passivhaus standard.

> *'You see the UK has a lack of ambition when it comes to building low energy buildings – well yes they do because they talk about carbon - can I put there are financial*

incentives in there cos there should be if people work it out properly but they just don't' - ***SS*** **– Policy Advisor**

This quotation focuses on the use of carbon which is the metric for UK Building Regulation Part L compliance but not the main metric of design for the Passivhaus standard.

The introduction of the UK Building Regulations Part L 2006 saw the introduction of Carbon/CO_2 as a main metric for building design compliance, so as to link building design directly back to UK national carbon reduction targets. Prior to this, the assessment metric in the Building Regulations had always been kWhs which is also the metric used in PHPP and the design of Passivhaus buildings. In order to achieve carbon compliance for the Building Regulations Part L, energy loadings for a building must first be calculated in kWhs and then converted into carbon/CO_2. For the Passivhaus standard PHPP uses kWhs but provides a conversion chart at the back of the spread-sheet to show what this might mean in terms of CO_2 emissions. Critics of the use of carbon as a metric believe it can provide misleading results in relation to delivering low energy/low carbon buildings since heat and energy generation sources and the carbon emissions associated with these can be subject to change through a building's life and in relation to national energy generation emissions fuel mix over time. This is indicated in recent reports produced by the ZCH and previously cited in this research (ZCH, 2011a)(ZCH, 2011b) in the history chapter of this thesis.

However the support for the statement relating to ambition may have more to do with the fact that the Passivhaus stakeholder group involved in this research are innovators and pioneers. They are therefore ahead of the mainstream in adoption of the new Passivhaus technology and may perceive others as lagging behind.

Precedent

The statement that '***The UK has many existing Passivhaus buildings to learn from***' is strongly disagreed with by this factor of opinion. This is based on the fact that there are currently few completed examples in the UK. It can therefore be concluded that UK Passivhaus stakeholders or others interested in building to the Passivhaus standard in the UK, have limited experience or first-had design knowledge and understanding from UK Passivhaus projects to learn from, as supported by the following quotation from a

Passivhaus Architect who is currently involved in the design of Passivhaus dwellings in the UK -

> *'the UK has many existing Passivhaus buildings to learn from – I disagree '***– P - Architect and Passivhaus Designer**

Factor Two Summary

This factor of opinion can be summarised, as with the Factor One, in a stakeholder belief in the ability of Passivhaus buildings to deliver comfort in the UK. Although there are many examples of accredited Passivhaus buildings in Germany and Austria that have been shown to deliver high levels of comfort, questions do exist around issues of indoor air-quality, and overall indoor air-quality which may be contingent on the quality of MVHR installation. These are combined with some overall issues relating to the acoustic characteristics of a Passivhaus building and the potential for MVHR to create noise irritation if incorrectly installed. There is however concern within this factor of opinion about the availability of precedent in terms of finished Passivhaus buildings in the UK for designers, contractors and potential occupants to learn from. This is a warranted concern since there are currently only a small number of completed accredited Passivhaus buildings in the UK. This is also supported by strong opinion, and the findings from the UK case studies, that the UK does not currently manufacture enough Passivhaus certified components to provide an adequate indigenous supply chain for successful delivery of Passivhaus buildings on a larger scale.

Factor Three – Short-Termism ('fast-buck' mentality), Representation, Ambition, Legislation and Planning

Most agreed with	Second most agreed with	Second least agreed with	Least agreed with
(23)The UK construction industry has a 'fast-buck' mentality	(35)The UK has a lack of ambition when it comes to building low energy buildings (43)Passivhaus needs strong and coherent representation in the UK	(25)UK current legislation favours Passivhaus design (1)The Passivhaus standard is well understood in the UK	(27)Our planning system supports the Passivhaus standard well

Factor Three is characterised by the statements ***'(23)The UK construction industry has a fast-buck mentality***' which is most strongly agreed with and the statement ***'(27)Our planning system supports the Passivhaus standard well***' which is most strongly disagreed with. After this, statements that are most strongly agreed with are ***'(35)The UK has a lack of***

ambition when it comes to building low energy buildings' and ***'(43)Passivhaus needs strong and coherent representation in the UK'***. Statements after this that are most strongly disagreed with are ***'(25)UK current legislation favours Passivhaus design'*** and ***'(1)The Passivhaus standard is well understood in the UK***'.

'Fast-buck' Mentality

From the interviews, the following stakeholder quotations relates strongly to the statement '***The UK construction industry has a fast-buck mentality***' – firstly -

> *'so the UK construction industry has a fast-buck mentality – and I have put this at the top because the thing that has driven the UK construction industry is, be it house building, be it commercial development, has been very short term – and this is a long culture to turn around but it is going to have to happen now because of shortage of resources, cost of labour, cost of building – those old approaches to design and build and the construction industry won't work in that kind of climate anyway – so that has been a major problem – so anything that has investment or long term thinking on the part of the developer or what required a client to think long term as well has – in the last 10 years it has been about how much money can I spend to make twice as much money when I sell it '* **- *FF* - Higher Education Lecturer/Architect**

And secondly the quotation from a contractor involved in building to the Passivhaus standard in the UK -

> *'We are doing some work with Loughborough at the moment and trying to improve the lean construction processes – which tends to be ignored because of the fragmentation of the industry – doing it more efficiently doesn't really matter because you are going out to tender as cheaply as possible' -* ***JJ*** **- Passivhaus Contractor**

Both the above statements seem to emphasise a focus on profit as opposed to quality in the building design and construction industries. The second statement particularly outlines the contractor's perception that cost and not efficiency and quality are the overriding factors that currently influence the procurement process for building design in the UK, with a stress that it is difficult to work outside these parameters and innovate if directly involved with building design consultancy or construction on a commercial basis.

Representation and Ambition

The statement '***The UK has a lack of ambition when it comes to building low energy buildings***' is also a key opinion for Factor Two and links to the statement that '***Passivhaus needs strong and coherent representation in the UK***'. It is also relevant to opinions about short-termism or a 'fast-buck' mentality in the UK construction industry, since the inference could be that there is a lack of will to support innovation and the communication processes surrounding the development of the Passivhaus standard. These could be because these cost more money than 'business as usual' solutions and do not necessarily result in short-term or immediate profits.

The above statements could be further supported by stakeholder quotations which describe the existence of a language barrier that may be preventing communication of Passivhaus understanding in the UK which may be exacerbated by the fact that UK organisations supporting the Passivhaus standard seem unwilling or unable to help bridge this gap through helping to support the translation of relevant German language research material or by employing staff with German language skills. The first quotation is from –a Passivhaus consultant and the second is from an engineer.

> *'I am a non-German speaker and the Passivhaus we are working on at the moment – the client is Dutch and he is a German speaker and he is using German contractors who are building Passivhauses and all the information that I require to certify the building is coming through in German'* - ***A*** **- Passivhaus Consultant**
>
> *'the fact that we haven't even translated the stuff into English is why you need strong and coherent representation – because no one company is going to do that off their own back – like the Sustainable Design Foundation or the Passivhaus Trust – we need a body to translate the manuals then we might have some more examples'* - ***Y*** **- Engineer**

The above respondent quotations could also help support the statement that '***Passivhaus is well understood in the UK***' which is generally not agreed with. This is potentially due to lack of precedent and indigenous research but also the fact that the majority of research literature underpinning this standard is currently only available in German and thus difficult for stakeholders in the UK to access.

Legislation and Planning

The statement '***Our planning system supports the Passivhaus standard well'*** is strongly linked to the statement '***UK current legislation favours Passivhaus design***' this could be reflected in the stakeholder quotation about UK planning -

> '*our planning system supports the Passivhaus standard well – no it f***ing well doesn't ... yes that is because I really feel strongly that because I am going through the planning process at the moment and I have seen in practice how the planners look at how well a building looks in keeping with its surrounding – and that seems to be the pre-eminent criteria and all other criteria seem to be... yeah – and not even whether they like it but whether it fits in with what is already there – so there doesn't seem to be anything else that can weigh against that – if it doesn't meet that criteria then nothing else really matters so it seems to be the tail that is swinging the cat*' -
> ***AA*** **- Passivhaus Client / Passivhaus Designer**

The above statement demonstrates the frustration felt by an early pioneer Passivhaus client/Passivhaus Designer in the UK with the planning system which he feels favours the aesthetics of the building design and its potential to fit visually within the existing built environment context rather than its potential for efficient energy performance and innovation.

Factor Three Summary

This factor of opinion could be summarised by a feeling from the stakeholders that the UK construction industry has a short- term or 'fast-buck' approach to business that does not support innovation because it cannot afford to. This is combined with a perception that the UK planning infrastructure's focus is away from building performance and energy performance and towards aesthetics, which does not potentially support the development of the Passivhaus standard in the UK. There is also considerable weight of opinion within this factor suggesting that the Passivhaus standard is not generally well understood and needs stronger and more coherent representation in the UK. There is also some opinion that this representation is potentially being hindered by language barriers.

Factor Four – Representation, Comfort, 'Fast-buck' Mentality, Precedent and Skills

Most agreed with	Second most agreed with	Second least agreed with	Least agreed with
(43)Passivhaus needs strong and coherent representation in the UK	(2)Passivhaus offers good comfort for occupants (23)The UK construction industry has a 'fast-buck' mentality	(1)The Passivhaus standard is well understood in the UK (15)The UK has many existing Passivhaus buildings to learn from	(9)UK construction skills are appropriate to build Passivhaus designs

The statement most agreed with in factor Four is that ***'(43) Passivhaus needs strong and coherent representation in the UK***' and the statement most disagreed with is ***'(9)UK construction skills are appropriate to build Passivhaus designs'***. The statements following this that are most agreed with are ***'(2)Passivhaus offers good comfort for occupants'*** and ***'(23)The UK construction industry has a 'fast-buck' mentality***' with the statements ***'(1)The Passivhaus standard is well understood in the UK***' and ***'(15)The UK has many existing Passivhaus buildings to learn from***' as being the second most disagreed with.

Representation, Comfort, 'Fast-buck' Mentality, Precedent Skills

Representation of Passivhaus in the UK is a key defining opinion for this factor and this reflects sentiment expressed in other factors that the Passivhaus standard is not well represented in the UK. This is supported by the fact that there is currently a lack of precedent in the UK since there are few completed accredited projects. The opinions next most disagreed with for this factor, are that '***UK construction skills are appropriate to build Passivhaus designs***' and the statement '***the UK construction industry has a 'fast-buck' mentality'***. This last statement is also highly significant in Factor Three and the statement about comfort is of key significance for both Factors One and Two.

Further stakeholder quotations to supplement those already used to reflect respondent opinion linked to the skills statement in Factor Three are given below. These statements help to support the thinking that there may currently be a lack of understanding of the skills required to build Passivhaus designs in the UK context.

> *'UK construction skills are appropriate, well they could be appropriate but they probably aren't'* **- *B* – Engineer/ independent Passivhaus Consultant and Trainer**

'UK construction skills – obviously I am not a contractor so I am not completely on the ground with construction skills but I think that more the issue about being able to do it is the detailing it is more to do with the quality than the skill – and attention to detail, maybe the way things happen is that people tend to do the least cost and the quickest so that is probably where it tends to lose out but I don't think necessarily that the construction skills are at fault it is more what is driving them' **- *T* - Building Services Engineer**

*'these guys are really precious but we don't seem to recognise it for some reason, particularly in this country I think and there is a question you have got in there about the skills and the skills aren't there' - **BB*** **- Passivhaus Client**

'UK construction skills are appropriate to build Passivhaus designs – well they are not – we just don't have the quality control on site – we don't have builders who are used to careful detailing – so we definitely need change in skills training ' **- *FF* - Higher Education Lecturer/Architect**

The above statements are significant because they show strong opinion in relation to contractor's skills, especially concerning detail design as from the perspective of consultants. They seem to suggest that there is a perception that there may be a potential gulf of understanding and appreciation between different professions or 'silos' of expertise in the building design and construction industry. This is combined with a feeling that cost is more important than quality. These sentiments are further reflected in the following quotation, which also expresses concern about client knowledge and inclination to deliver a quality performance product for the long-term, which could be described as a 'fast-buck' mentality.

'In terms of trying to achieve a good end building performance my perception is that you need to pay a lot of attention to the basics and the detailing and I think that is something that there is not a lot of focus on generally in the professions – particularly in the architectural profession certainly in terms of energy performance – and just from my perception really and there is not really much encouragement from the clients either because it is more about how it looks and how it is going to sell – not necessarily about how it is going to perform in 8 years' time – whether or not it was

robust and whether the seals were going to deteriorate or even be air-tight in the first place so I guess they are linked' ***- X -*** **Engineer**

Factor Four Summary

The main opinion focus for this factor appears to be that the Passivhaus standard is currently not well represented in the UK and that the UK consulting and construction industries currently lack the skills that are required, for the delivery of Passivhaus buildings in the UK. This is particularly relevant to detail design. There is also an underlying opinion within this factor that UK procurement processes, which are perceived as being short-term and profit based, rather than aimed at delivery of quality of design, are also a hindrance to the delivery of Passivhaus buildings in the UK.

Factor Five – Representation, Energy Performance, Fear of Low Air-Permeability, Financial Incentives, Precedent and Policy

Most agreed with	Second most agreed with	Second least agreed with	Least agreed with
(43)Passivhaus needs strong and coherent representation in the UK	(21)People associate low energy building with on-site renewable energy technologies not fabric performance (34)People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	(5)There are financial incentives to build Passivhaus designs in the UK (15)The UK has many existing Passivhaus buildings to learn from	(13)The Code for Sustainable Homes is a better standard than Passivhaus

The statement most agreed with for this factor is ***'(43)Passivhaus needs strong and coherent representation in the UK***'. This is followed by the statements, ***(21)People associate low energy building with on-site renewable energy technologies not fabric performance***' and ***'(34)People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs***' which were less strongly agreed with. The statement most strongly disagreed with was ***'(13)The Code for Sustainable Homes is a better standard than Passivhaus***' followed by the statements that were less strongly disagreed with - ***'(5)There are financial incentives to build Passivhaus designs in the UK***' and ***'(15)The UK has many existing Passivhaus buildings to learn from'***.

Representation, Energy Performance, Fear of Low Air-Permeability, Financial Incentives, Precedent and Policy

Again the statement relating to the representation of Passivhaus in the UK (which is also a strongly weighted statement of opinion for Factor Four) is important for this factor since it is about the statement relating to existing precedent. These two statements act to reinforce the perceived need for precedent as part of representation but also a feeling that representation of the Passivhaus standard appears to be lacking in the UK.

The statement least agreed with for this factor is '***The Code for Sustainable Homes is a better standard than Passivhaus'***. This could be supported by the following statement from an accredited UK Passivhaus designer which seems to highlight a feeling of distrust with the current UK CSH design tool and an appreciation of the perceived technical rigour that relates to designing Passivhaus buildings using PHPP.

> *'…as for the Code for Sustainable Homes, whether it is better than Passivhaus – they are completely different in the gross respect – Passivhaus can tie in quite neatly with the Code but the Code does look at a broader array of subjects but it doesn't really address enough subjects to be truly sustainable and it also includes a lot of perverse incentives that are in doubt – whereas if you went through PHPP to look at primary energy to produce showers – the rainwater harvesting systems have a lot of parasitic energy loads associated with them which can be higher in the carbon emissions for mains water – so there are certain questions that can be asked about the tool in that way, which – so the argument for Passivhaus is one of rigour and not only a thing that may be covered by Passivhaus at the moment – but there is a certain philosophical approach to the rigour which I think could be widely adopted in the UK to the benefit of the country.'* **- *E* - Architect / Certified Passivhaus Designer**

Air-Permeability and Performance

The following quotation which is linked to air-permeability demonstrates the opinion of one stakeholder as to how he perceives those in Germany and Austria view the UK and its target for '*zero carbon'* buildings in 2016 and 2019.

> *'they look on with bemusement – especially wondering what on earth we are doing – here we are people clearly incapable of building any Passivhauses – til last year or so - clearly incapable of meeting the air-tightness standards and here we are claiming to*

do in 2016, we are going to have zero carbon homes – it is a joke – they think we are peculiar – and I think they are right – it is just not linked to reality at all' ***- B -***

Engineer / Independent Passivhaus Consultant and Trainer

This quotation is also of specific relevance when considering the fact that the air-tightness/air-permeability targets that are required to meet current UK Building Regulations Part L 2010 is 10 $m^3/hr/m^2$ @ 50 pa with a best practice recommendation *of 3 $m^3/hr/m^2$* but the requirement to meet the Passivhaus standard is 0.6 $m^3/hr/m^2$. Consultation surrounding the development of the Building Regulations Part L 2013 is however reviewing the reduction of air-permeability design targets of '*3 $m^3/hr/m^2$'*(CLG, 2012)

A Passivhaus contractor describes a more enlightened approach to air-permeability testing but also the problems surrounding the training of contractors to build better air-tight buildings. The ability for contractors to consistently deliver high fabric performance and low air-permeability is considered to be a problem that is partly linked to the transient nature of construction teams -

'we have improved our air-tightness and one of the ways that we have done that is that when we are actually doing the air-testing, our guys watch – we get our carpenters to watch it and they have actually made changes based on site simply based on what they have picked up from seeing stuff, so they understand why you are doing it but if you didn't have the continuity of staff you wouldn't get that, you'd just have people there for a couple of months and then disappear off' - ***JJ -***

Passivhaus Contractor

A point brought up by an architect working for the UK Passivhaus Trust is that although all Passivhaus buildings are measured through on-site air-pressure testing, they are not all routinely monitored in terms of overall post-construction energy performance. There have however been large numbers of Passivhaus buildings that have been monitored for POE and energy performance inclusive of the 229 used as part of the CEPHEUS research and hundreds in Germany and Austria since CEPHEUS. (Keul, 2010a)

'yes exactly – but there is air-tightness that is one measurement that they are taking – but in terms of gross energy use for electricity or gas – so that is an extra – it is an issue' **- *D* - Architect and Passivhaus Consultant**

'yes because air-tightness is quite important and even small changes in that have quite big impacts – I don't know if this is something that they have looked and say – if they match the air-tightness and haven't completely messed something else up then – I guess that Matthias who is the German/EU database manager said well in 5/10 years down the line this will be the standard and we will all be doing it so what will be the point – again quite optimistic – but I think we need to know at this stage what we are achieving' **- *D* - Passivhaus Consultant and Architect**

In relation to the above statements, the testing carried out as part of the Kranichstein housing and CEPHEUS programme has shown the importance of meeting the low air-permeability requirements for Passivhaus energy savings and this is again supported by research carried out by Lowe (Lowe, 2000)in the UK.

The above is a particularly resonant statement if considering many of the other stakeholder opinions surrounding UK construction skills and client integrity for the delivery of quality buildings, but also findings from Clarke and Herrmann (Clarke and Herrmann, 2004) about skills gaps between the quality of UK and German construction industry labour.

Air-permeability and On-site Renewables

Statements with strong weightings which do not make up the opinion matrix of the other four factors are '***People associate low energy building performance with on-site renewable energy technologies not fabric performance***' and '***People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs***'.

The following quotations from stakeholders are about issues of perception in relation to air-tightness/air-permeability -

'yes because when you deal with planning the arguments from some people/ developers when you try and go for higher levels of air-tightness are – is 'the biggest issue they face is summer overheating' – so they think that people will suffocate' - ***OO*** **- London Planner**

'I don't really think our clients are that bothered about it (air-tightness) – if you took a sensible approach you wouldn't do it, you wouldn't build to those levels because you should build what your client wants really' ***- JJ -*** **Passivhaus Contractor**

The above quotation also links back to general respondent feelings that it is the client who decides what to build and this choice is usually linked to capital cost as opposed to overall energy performance over the life of a building. The quotations also demonstrate perceived potential anxiety and a lack of understanding surrounding air-permeability and fabric design amongst clients and some construction industry protagonists.

Financial Incentives

In terms of the statement '***There are financial incentives to build Passivhaus designs in the UK'***, this could be supported by the following quotations from stakeholder interviews -

'*I don't know if there are financial incentives but there is not much financial incentive for low energy building schemes anyway'* ***- U -*** **Engineer**

'There are financial incentives to build Passivhaus designs in the UK – I think in terms of the life-cycle of the building and fuel costs but no other incentives that I can think of' ***- P -*** **Architect and Passivhaus Designer**

These quotations suggest a degree of confusion about the availability of financial incentives to build a Passivhaus in the UK. At the time of this research, no direct financial incentives were in existence. This is unlike the situation in Germany, (where many of Passivhaus developments have been constructed to date) where the KfW (Kreditanstalt für Wiederaufbau) Bankengruppe, now offers low interest loans to those constructing new low energy building or renovation projects. This includes for support of Passivhaus projects(PHI, 2012b)

In conjunction to this, it could be argued that accurate build or running costs associated with UK Passivhaus construction do not currently exist in sufficient quantity to provide guidance for all those wishing to build to the Passivhaus standard in the UK, or to help act as an incentive to build to the Passivhaus.

Factor Five Summary

As with Factor Four, the main focus of opinion for this factor appears to be that the Passivhaus standard is currently not well represented in the UK. Other strong opinion from this factor relates to a potential frustration with the credibility of the existing low energy design standard the CSH to deliver very low energy or Passivhaus buildings in the UK. This factor of opinion also has a strong focus on perception relating to low levels of air-permeability and the use of on-site renewable energy technologies. It seems that the belief is that these aspects of building design are not currently well understood or well delivered in the UK. This factor of opinion also focuses on the lack of financial incentives which are available to support Passivhaus and low energy building design standards in the UK. This is in contrast with availability of financial support in Germany which is demonstrated in the availability of low costs loans for the KlimaSolarHaus in the case studies and financial support for the development of the Kranichstein test housing and CEPHEUS programme.

Summary of Interpretation of Factors

To summarise the interpretation of all five factors it would appear that the respondent group believes that while Passivhaus buildings have the potential to perform well and offer high levels of comfort for occupants in the UK, the standard is not currently well represented or understood in the UK. It is also not currently well supported by relevant UK supply chains, procurement systems, skills, legislation, financial mechanisms, precedent or client or political will. The Passivhaus standard is at the very early stages of adoption in the UK and as such there is only limited design, construction and development experience precedent to learn from.

At the end of undertaking this research, only 24 (Passivhaus Trust, n.d.) accredited Passivhaus buildings had been constructed, or were under construction in the UK, three of which have been included as case studies. The standard was at the earliest 'Innovator' stage of adoption and thus there was little in-depth indigenous knowledge about how to design and deliver buildings to this standard. While many of the respondents undertaking the Q-tests were directly involved in the design and construction of these early Passivhaus projects, others had varying degrees of expertise surrounding the Passivhaus standard. Despite this their opinions, when ordered into factors start to present a snap-shot of the

group opinion as to the potential, barriers and opportunities surrounding the development and uptake of this innovation within this group in the UK.

Despite the Passivhaus standard being new to the UK and at the earliest stages of adoption, those initially building to the standard appear to have successfully produced developments performing to the standard. Key areas of opinion that have been perceived as obstacles lie is in the field of communication, precedent, skills and costs. This not only relates to supportive representation of the standard in the UK, which could allow for clear explanations as to what a Passivhaus is, how it performs, how to cost and design and construct one, but also cross-industry and cultural communication for more mainstream parts of the UK consulting and construction industries.

Much detailed research has been carried out into Passivhaus buildings constructed in mainland Europe. This research does not currently seem to be fully percolating the UK construction environment. This leaves UK Passivhaus stakeholders to learn for themselves, through trial and error, how to design and deliver Passivhaus projects. Likewise it is not apparent that much academic research carried out into UK low energy building projects is currently being successfully and consistently communicated to wider industry. In conjunction to this the opinions of this stakeholder group seem to suggest that there is some degree of mistrust of information that is being delivered to industry through current state/government mechanisms which is informing the nature and content of current UK Building Regulations and design standards such as the CSH. It also appears to be against rather than in conjunction with indigenous regulations, standards and planning mechanisms that those working with the Passivhaus Standard must currently deliver Passivhaus buildings in the UK. Although there is some apparent scope for integration, which has been highlighted in the case study examples.

Overall the picture presented by these factors of opinion from UK Passivhaus innovators/ pioneers, is of a group with variable knowledge about the Passivhaus standard working against current UK systems. The aim to deliver a product that they believe will work, mostly based on evidence from other European countries, but this product is currently not well supported by the incumbent construction industry environment in the UK.

These factors of opinion represent those from a small group but they may be relevant to the wider construction industry since they could start to act as a pot of distilled information which might indicate areas which are potential barriers or opportunities surrounding the uptake of this new technology/innovation in the UK on a wider scale. This premise would however have to be tested with further research, especially when considering the fact that separate groups in the chain of innovation may react in different ways, as highlighted in research in the book 'Crossing the Chasm' by Moore (Moore, 2007).

Comparison between Q-Methodology Opinion Factors and Passivhaus Case Studies

The conclusions from the case study research were that all of the case studies chosen are pioneering and exemplar buildings. Great care has been taken by each of the procurement, design and construction groups to ensure that the developments are a success. It is also evident that additional costs were incurred (or were offset by cheap/free land) by all but one of the five projects. These costs were mostly attributed to the learning curves associated with the development of early Passivhaus projects, but correlate with findings from early and recent German developments that understand that projects, will on average, cost more than normal build standard developments (PHI, 2012b). In the case of the UK, additional construction costs were also associated with the lack of availability of indigenous component parts such as UK manufactured Passivhaus accredited MVHR units or windows.

The projects have all been well received by clients and occupants but there have been learning curves associated with understanding how to live in and operate these buildings. In all cases designers, occupants and residents have had to learn how to negotiate the use of MVHR which has been a new or relatively new technology for all. They have also needed to take a more active role in maintaining their own thermal comfort by remembering to close windows or use sun-shading as appropriate.

Q-Factors compared with Case Studies

The summaries from the five key factors of opinion drawn from the Q-methodology analysis have been extracted from the Q-Methodology Results chapter and are use here to make a direct comparison with results from the individual case studies.

Factor One – Comfort, Climate, MVHR and SAP

Factor One Summary ***Comfort, Climate, MVHR and SAP***	*In summary the significant opinions defining this factor seem to focus on a belief in the capacity for the Passivhaus standard to deliver high levels of indoor comfort, but with doubt being cast on the competencies and understanding from the UK consulting and construction industries to deliver adequate fabric performance and the necessary MVHR design and installation for this to be realised on a consistent basis in the UK. This is in part supported by recent research from the Netherlands and potentially by some of the findings of the German POE case studies included in this thesis. The issues relating to delivery of fabric performance and MVHR installation are also supported by recent academic research undertaken in the UK by Oxford Brookes and Leeds Metropolitan Universities (cited above) and the of findings from examination of projects at the BRE Innovation Park.* *This factor also focuses on the differences between PHPP and SAP and the belief by respondents that SAP is not able to deliver the accuracy of calculation required for very low energy 'Passivhaus ' buildings in the same way that PHPP can, despite some reflection on the difficulty that some designers have when using PHPP.*
Canolfan Hyddgen	This project has been well received by its client and occupants and has been shown to perform in accordance with design intentions. Key issues raised by the architect concerning the construction of this building were that it was essential to maintain quality control of the construction detail to ensure meeting the Passivhaus standard. This was achieved through the appointment of specific individuals on site who were directly

	responsible to oversee this and supervise the continuity of the air-tightness barrier. This type of approach to design is recommended by the PHI in Darmstadt and supported by their research which has informed their Protokollband 18 (Feist et al., 2008). Recent research undertaken by Leeds Metropolitan University into the Stamford Brook project (Wingfield et al., 2007) and feedback from analysis of feedback from developments at the BRE Innovation Park have shown that attention to design and construction detail are vital for the delivery of low energy homes (Gaze et al., 2008). The architect for this development had trouble convincing the German manufacturers of the MVHR units to supply them for this project because they were worried about the competencies of the UK construction team to install them correctly (Williamson, 2012). The architect also had to carry out much of the PHPP calculations and undertaken some of the mechanical and electrical design of this building at risk because of the UK engineer's unwillingness to work with a non-UK design standard and new approaches to design.
The Larch House	The architect for the Larch House chose to specifically employ German contractors to come and train Welsh contractors how to construct and install key component parts of the house so that it would meet the Passivhaus standard. This included the windows. The architect also located the MVHR unit in an accessible cupboard on the ground floor and has provided additional occupant instructions as to how to use this and other systems in the house. These have been provided on a poster for clarity.
The Denby Dale House	This house was successfully constructed by a small team of local builders, but with detailed supervision by both the architect and key consultants inclusive of members of the Green Building Store who have seen this as a landmark project for their business. Care was therefore taken to deliver an accurate and functional development. The client occupants of the house have noted that they have had to learn

	to live with the new systems such as MVHR and have commented that it would be useful for future developments if there was some kind of occupant manual available in order to help them do this and to understand living in the house. The occupants expressed a high degree of satisfaction with comfort levels in this building.
St. Jakob's	The majority of the feedback from this case study is drawn from occupant experience as opposed to feedback from design and construction processes. Occupant feedback tells us that the occupant group were involved with the project prior to the design and construction of the building and are now involved in operating and maintaining it. Early occupant engagement meant that occupants learnt about the processes needed to operate the building from the earliest stages. They were therefore aware of the parameters surrounding the operation of the MVHR systems when they moved in. Nonetheless some learning curves were associated with overall operation of the dwellings in order to maintain optimum thermal comfort. All residents interviewed expressed a high degree of satisfaction with comfort levels in their flats.
KlimaSolarHaus	As with the case study above, the majority of the feedback from this case study is drawn from occupant's experience as opposed to feedback from design and construction processes. Also as with the above project, the occupants were involved from the earliest stages of the project prior to its design and construction. The occupants were therefore aware of the parameters surrounding the operation of the MVHR and other systems when they moved in and are partly responsible for maintaining these. They did however experience some early problems when understanding how to live with and operate the whole-house MVHR system. All the residents interviewed expressed a high degree of satisfaction with comfort levels in this building.

Factor One - Case Study Comparison Conclusions

In summary, opinions represented by Factor One in relation to Passivhaus buildings having the potential to offer a high degree of comfort for occupants seem to have a basis in actual feedback from residents of the case studies. There also seems to be some basis for truth in the opinions about construction competencies and the need for them to be of a high standard to deliver Passivhaus buildings. The doubts about existing UK construction competencies are reflected in findings from academic research in the UK (Clarke and Herrmann, 2007)and research undertaken by the IEE (IEE, 2006). The quality control of the design and construction processes, particularly in relation to air-tightness and thermal bridge details, but also with the design, installation and understanding of the operation of the MVHR system appear to be essential for the successful delivery of Passivhaus buildings.

Factor Two – Comfort, Energy Performance, Supply Chain, Ambition and Precedent

Factor Two Summary ***Comfort, Energy Performance, Supply Chain, Ambition and Precedent***	*This factor of opinion can be summarised, as with the factor One, in a stakeholder belief in the ability of Passivhaus building to deliver comfort in the UK. Although there are many examples of accredited Passivhaus buildings in Germany and Austria that have been shown to deliver high levels of comfort, questions do exist around issues of indoor air-quality, and overall indoor air-quality which may be contingent on the quality of MVHR installation together with overall issues relating to the acoustic characteristics of a Passivhaus building and the potential for MVHR to create noise irritation if incorrectly installed. There is however concern within this factor of opinion about the availability of precedent in terms of finished Passivhaus buildings in the UK for designers, contractors and potential occupants to learn from. This is a warranted concern since there are currently only a small number of completed accredited Passivhaus buildings in the UK. This is also supported by strong opinion, and the findings from the UK case studies, that the UK does not currently manufacture enough Passivhaus certified components to provide an adequate indigenous supply chain for successful delivery of Passivhaus buildings on a larger scale.*
Canolfan Hyddgen	The client and occupants of the Canolfan Hyddgen have expressed a high degree of satisfaction with their building and recorded temperature readings have remained within designed comfort levels. The architect for this project used non-UK manufactured Passivhaus components such as the MVHR units and windows due to a lack of availability of appropriate UK components at the time of construction.
The Larch House	There is currently no occupant feedback from this house. The architect specified non-UK manufactured key Passivhaus components such as MVHR unit and windows due to lack of availability of such products in the UK at the time of construction. The architect has since been working to develop UK manufactured Passivhaus windows and who helped influence

	the WAG to support the development of Welsh manufactured high efficiency MVHR units.
The Denby Dale House	According to the case study in this thesis, a high level of occupancy satisfaction and comfort has been recorded for this project. The designers of this house specified non-UK manufactured key Passivhaus components due to lack of availability of suitable products at the time of design and construction of this house. It was not possible to obtain a small enough boiler as required to meet the low heat loads. The occupants have had to learn to live in their new house and noted that for future projects it would be a good idea if some kind of operating instructions were available.
St. Jakob's	Feedback from interviews with residents of this development have shown a high degree of satisfaction with comfort levels, but that occupants had to learn how to operate their flats/building in order to optimise these. Some issues were also noted with dry quality of indoor air. Key Passivhaus components were available from German and other EU manufacturers.
KlimaSolarHaus	Feedback from interviews with residents of this development have shown a high degree of satisfaction with comfort levels, but that occupants had to learn how to operate their flats/building in order to optimise these, this included for understanding how to work with the central MVHR system and other central plant systems. Key Passivhaus components were available from German and other EU manufacturers.

Factor 2 Case Study Comparison Conclusions

The opinion expressed by Factor Two that Passivhaus buildings offer good comfort for occupants seems to be grounded in some reality when examining the feedback from occupants of the case studies. Some issues were however observed in relation to dry quality of indoor air and acoustics. All the case studies are located in different geographic regions with different climates. The developments are also built in a variety of construction types. This appears to show that the Passivhaus standard is potentially appropriate for different climatic regions within the UK and Germany.

Significantly occupants have had to learn how to operate their buildings to achieve optimum indoor thermal comfort levels.

While German supply chains for Passivhaus products have already been developed, current UK supply chains appear to be embryonic. The construction of these early accredited Passivhaus projects in the UK does however seem to be working as a catalyst for the development of some accredited Passivhaus products in the UK.

Factor Three – Short-Termism ('fast-buck' mentality), Representation, Ambition, Legislation and Planning

Factor 3 Summary ***Short-Termism ('fast-buck' mentality), Representation, Ambition, Legislation and Planning***	*This factor of opinion could be summarised by a feeling from the stakeholders that the UK construction industry has a short- term or 'fast-buck' approach to business that does not support innovation because it cannot afford to. This is combined with a perception that the UK planning infrastructure's focus is away from building performance and energy performance and towards aesthetics, which does not potentially support the development of the Passivhaus standard in the UK. There is also considerable weight of opinion within this factor suggesting that the Passivhaus standard is not generally well understood and needs stronger and more coherent representation in the UK. There is also some opinion that this representation is potentially being hindered by language barriers.*
Canolfan Hyddgen	The Canolfan Hyddgen was the first accredited Passivhaus building in the UK and required trust from PCC with the architect and design team that the delivered product would perform as anticipated. The mechanical and electrical engineers for the project were reluctant to undertake some of the design work for the project since some of the installation was not within their usual competencies or consistent with typical UK design approaches and legislation. One key element of feedback from the architect relates to the complexity of having to innovate within the context of the existing Local Authority fixed procurement systems. Despite these factors the client and architect were willing to adopt and were supportive of the Passivhaus standard as an innovation in this case.
The Larch House	The Larch House was specifically built in response to a WAG competition. This meant that both WAG and the housing association client were supportive of this new innovative type of building standard and willing to allow for experimentation. Likewise BRE Wales who were also involved

	with the project from the earliest stages were also supportive of the project. Both WAG and BRE have seen the Larch House as a potential catalyst for the development of low energy housing and the associated supply chains and skills needed to deliver this in Wales. At the time of construction the Larch House the Passivhaus standard was not well understood in Wales or the UK but, through delivery of this project now offers precedent for and better understanding of the standard.
The Denby Dale House	The Denby Dale Passivhaus was built using the typical UK cavity wall construction. This was in part to prove that it is possible to build to the Passivhaus standard using this construction method (which is typical in the UK), but also to appease planners who wanted to see a house that was aesthetically in keeping with the local surroundings. The client/occupants put trust in the design and construction team to deliver an affordable retirement home for themselves. This house was constructed by a private client using local builders and not main stream house builders who could have used such an exemplar as an R+D exercise to further their business concerns.
St. Jakob's	At the time of construction few if any of the current occupants of the St. Jakob's development had any idea what a Passivhaus was. The project was supported through the provision of cheap rental land on a 100 year lease from the Church. They were recruited via a newspaper advertisement and educated about Passivhaus design during the procurement process. Passivhaus is now the regulatory build standard for all new public buildings in Frankfurt.
KlimaSolarHaus	At the time of construction few if any of the current occupants of the KlimaSolarHaus development had any idea what a Passivhaus was. They were recruited via a newspaper advertisement and educated about Passivhaus design during the procurement process. Unlike all the UK case studies this development received direct financial support from the German Government via a low cost loan from the KfW bank for part of

	the project costs.

Factor Three - Case Study Comparison Conclusions

The UK case studies seem to demonstrate a scenario where individuals and local government have been willing to take risks to support innovation research and development of Passivhaus projects, but this has been against some existing procurement systems, as demonstrated in the Canolfan Hyddgen project.

It is however of interest that most of those involved in this specific innovation process have been small sized organisations as opposed to larger UK contractors or consultants. The two Welsh projects were however supported by the regional government WAG.

While it is clear that all the UK Passivhaus projects are pioneer projects, they were successfully delivered by stakeholders who had little or no prior experience of Passivhaus design and construction. The success of these projects appears to demonstrate that, despite an opinion from the results of the Q-tests that the UK construction industry has a 'fast-buck' mentality, there are some within this industry who do not conform to this premise. However the opinion about a 'fast-buck' mentality may be relevant when examining the findings of tests undertaken at the BRE Innovation Park on developments constructed by larger firms of contractors which is supported by research from Oxford Brookes University and BRE previously cited.

It is also clear that at the time of procurement of both the German projects that the Passivhaus standard was not well understood by general members of the public in either Frankfurt or Berlin. Since this time the Passivhaus standard has been adopted by the City of Frankfurt for all new public housing (Laible, 2010a)

Factor Four – Representation, Comfort, 'Fast-buck' Mentality, Precedent and Skills

Factor Four Summary ***Representation Comfort, 'Fast-buck' Mentality, Precedent and Skills***	*The main opinion focus for this factor or opinion appears to be that the Passivhaus standard is currently not well represented in the UK and that the UK consulting and construction industries currently lack the skills that are required,(particularly in attention to detail), for the delivery of Passivhaus buildings in the UK. There is also an underlying opinion within this factor that UK procurement processes, which are perceived as being short-term profit based as opposed to aimed at quality of design delivery and are therefore a hindrance to the delivery of Passivhaus buildings in the UK.*
Canolfan Hyddgen	The Canolfan Hyddgen was the first accredited Passivhaus building in the UK. Prior to this some examples of similar super-insulated buildings have been constructed in the UK from the 1970's. While there are now at least three key organisations representing the Passivhaus standard in the UK, the standard exists outside the mainstream and or Building Regulations and Legislation. This Passivhaus development was supported by local and regional government in Wales, but delivered by a small architecture practice and mostly local contractors and consultants. The client for this building has procured it for the long-term, rather than for re-sale. The architect paid special attention to the detailing of this project particularly in relation to the air-tightness barrier.
The Larch House	As with the Canolfan Hyddgen this Passivhaus development was supported by local and regional government in Wales, but delivered by a small architecture practice and mostly local contractors and consultants. This house is owned by a housing association for the long-term - it will be rented to tenants in the future. As mentioned previously, the architect chose to employ some German contractors to teach the local Welsh contractors how to install key Passivhaus components such as windows.
The Denby Dale House	As with both the above Passivhaus developments this was supported by

	local and regional government, but delivered by a small architecture practice and local contractors and consultants. This house has been built as a retirement home for the occupants who intend to stay there for a long period of time.
St. Jakob's	This project was delivered by experienced Passivhaus architects and contractors with those in Frankfurt learning from expertise gained working in other German states. The occupants bought into this development for the long-term as opposed to short-term profit.
KlimaSolarHaus	This project was delivered by experienced Passivhaus architects and contractors with those in Berlin learning from expertise gained in other German states. The occupants bought into this development for the long-term as opposed to short-term profit.

Factor Four - Case Study Comparison Conclusions

This factor of opinion focuses on representation and skills as major issues currently affecting the uptake of the Passivhaus standard in the UK, but with these issues having roots in short-termist approaches in the UK building design and construction industries. This could be supported by evidence from study of the recent housing developments at the BRE Innovation Park but has also been a recurrent theme in Government reports about the construction industry over the past 20-30 years, such as the Egan Report (Egan, 1998) etc.

All the UK case studies were delivered by small architects, consultant and construction teams who took risks to deliver these projects. It is again interesting to note that these successful projects were not delivered by larger consultants or contractors as was the case with the experimental super insulated CSH housing built at the BRE Innovation Park.

Metering and monitoring of the UK Passivhaus case studies seems to show that the projects are performing well in comparison to design intentions whereas many of the projects at the BRE Innovation Park seem to have fallen short in terms of either cost or performance.

Factor Five – Representation, Energy Performance, Fear of Low Air-Permeability, Financial Incentives, Precedent and Policy

Factor Five ***Summary*** ***Representation, Energy Performance, Fear of Low Air-Permeability, Financial Incentives, Precedent and Policy***	*As with Factor Four, the main focus of opinion for this factor appears to be that the Passivhaus standard is currently not well represented in the UK. Other strong opinion from this factor relates to a potential frustration with the credibility of the existing low energy design standard the CSH to deliver very low energy or Passivhaus buildings in the UK. This factor of opinion also has a strong focus on perception relating to low levels of air-permeability and the use of on-site renewable energy technologies as it seems that the belief is that these aspects of building design are not currently well understood or delivered in the UK. This factor of opinion also focuses on the lack of financial incentives which are available to support Passivhaus and low energy building design standards in the UK. This is in contrast with availability of financial support in Germany which is demonstrated in the example of the KlimaSolarHaus in the case studies*
Canolfan Hyddgen	This development was built to both the Passivhaus standard and BREEAM Excellent and at no apparent extra cost in comparison to only meeting the requirements of BREEAM Excellent. Its overall performance to date appears also to be saving the client money through running costs. It can therefore be concluded that the Passivhaus standard can be compatible with existing UK legislation. Extra work is however required to prove compliance with both standards. An area where incompatibilities can be noted are into the requirements for meeting UK Building Regulations Part F for ventilation, which requires higher ventilation rates than those required to meet the Passivhaus standard.
The Larch House	This house was designed to meet the requirements of the Passivhaus standard and the CSH Level 6. It therefore shows that these two standards can potentially be compatible. Extra work and therefore cost was however required to prove compliance with both standards.

The Denby Dale House	This house was only designed to meet the requirements of the Passivhaus standard. When examined against criteria to meet the requirements of the CSH it only reached Level 3 of 6 Levels, despite having a higher fabric performance than would generally be associated with meeting this level of the CSH. Reasons for not gaining a higher CSH Level are linked to its lack of on-site renewable energy technologies.
St. Jakob's	This building was constructed on land leased by the church and has formed part of the precedent influencing the requirement that all new public housing in Frankfurt is built to the Passivhaus standard.
KlimaSolarHaus	This building was constructed with German government support through a low interest loan from the KfW Bank.

Factor Five - Case Study Comparison Conclusions

The core opinions from this factor have similarities to those of Factor Four in the belief that the Passivhaus standard is not currently well represented in the UK. The other key opinion for this factor is that the Passivhaus standard is better than the CSH. If this is reviewed in relation to findings from the UK case studies, it can be seen that there is apparently potential for the CSH and the BREEAM standard (which is the equivalent standard to the CSH but for non-domestic buildings) to work together in parallel with Passivhaus despite the fact that they deal with a different palette assessment mechanisms. The Passivhaus standard concentrates on fabric and energy performance whereas the CSH and BREEAM cover other areas of sustainability assessment such as materials and water use in conjunction with the requirement for on-site renewable energy technologies. However, findings from the Denby Dale Passivhaus case study potentially begin to show discrepancies between the CSH and the Passivhaus standard in their requirements to prove overall building and energy performance with a high reliance being placed on the use of on-site renewable energy technologies in the case of the CSH.

If however UK buildings are to be delivered to both CSH or BREEAM and the Passivhaus standard concurrently, this incurs extra costs since the processes and calculation methods used to achieve each are different with both currently having to be undertaken as separate assessments.

In conjunction with this, the current UK requirements to meet both Building Regulations Part L and F are not necessarily specifically compatible with the Passivhaus standard. This is particularly relevant to the requirements to meet Part F which are for higher levels of ventilation for non-domestic buildings than is required to meet the Passivhaus standard. In addition to this there is opinion founded in research that the energy assessment tool SAP which is used for both Part L and CSH compliance is not currently sensitive enough in many areas to deliver buildings designed to the Passivhaus standard (AECB, 2008)

This factor of opinion also focuses on a lack of current UK financial incentives to support new low energy building innovations such as the Passivhaus standard. While no similar funding mechanism from a bank like the KfW currently exist in the UK, a degree of support has been given to two of the UK Passivhaus case studies through the WAG. Similar support has not been apparent in other UK regions at the time of this research.

Discussion

> *'Unless we know the tools, we cannot possibly control them nor begin to sense the limits and possibilities out of which solutions can emerge.'* Robertson Ward (Herbert, 1984)

When examining the findings from the Q-analysis in combination with the case studies and the Passivhaus history, the general themes of process, protocol, cost ,representation, supply and understanding of specific technologies (such as MVHR) start to emerge as consistent. These themes may hold some of the keys to understanding both the barriers to the development of and potential opportunities surrounding the evolution of the Passivhaus standard in the UK.

An examinatinon of the history of the development of the Passivhaus standard shows us that a carefully researched and managed process has been integral to the development of the Passivhaus standard in Germany. For example, the CEPHEUS programme which allowed for the development of prototypes, inclusive of feed-back from the testing of projects and inhabited buildings, has not only produced valuable research data but led to the successful evolution of the Passivhaus standard and supporting industries and social and technological infrastructure and clusters in Germany and the EU. This gradual but staged process has been successful in delivering a final or near 'closed' innovation whereas similar but unco-ordinated and less structured research developments of super insulated buildings in the UK have not (to date) resulted in the same. This is despite the production of recent valuable research findings from developments such as the BRE Innovation Park and others.

The key factors of opinion from the Q-analysis (listed below) also highlight major themes surrounding the understanding of specific technical processes and technologies, the barriers of incumbent systems and short-termist 'Fast-Buck' mentality of the UK construction industry combined with a lack of representation for the Passivhaus standard in the UK. The themes however demonstrate a belief by the Q-test protagonists that the Passivhaus standard is a viable design standard for the UK and has the potential to deliver high levels of comfort and energy performance in UK buildings.

Q-analysis Factors of Opinion

- Comfort, Climate, MVHR and SAP
- Comfort, Energy Performance, Supply Chain, Ambition and Precedent
- Short-Termism ('fast-buck' mentality) , Representation, Ambition, Legislation and Planning
- Representation ,Comfort, 'Fast-buck' Mentality, Precedent and Skills
- Representation, Energy Performance, Fear of Low Air-Permeability, Financial Incentives, Precedent and Policy

These factors of opinion and their interpretation only present a 'snap-shot' picture of opinions from an innovator group but start to outline some of the key issues that potentially need to be addressed if the Passivhaus standard is to be successfully developed as a design standard in the UK, both with innovators and within the mainstream construction culture.

Although the factors represent opinions from a small group involved at the earliest stages of development of the Passivhaus standard in the UK, and the number of architectural case studies used is small, an understanding of the premise surrounding Q-methodology research (Stephenson, 1936) (Stephenson, 1935)and the findings of Flyvberg (Flyvberg, 2006) in relation to case studies, tell us that the key factors of opinion from the Q-methodology analysis combined with issues encountered in the architectural case studies are of value in themselves. They also have the potential to reflect significant issues and themes that will probably also be relevant to later adopters of the Passivhaus standard in the UK, and/or those wishing to work with the Passivhaus standard in the UK.

It is possible that these experiences and opinions may also be similar to those held by a comparable innovator group in Germany in the early 1990's, when the Passivhaus standard was first being developed there, and also potentially to groups in other countries or communities. This would however have to be tested as part of further research.

Since the initial development of the Passivhaus standard in Germany, the standard has progressed to a later stage of adoption than in the UK with an estimated excess of 30,000 Passivhaus buildings having been constructed, (PHI and iPHA, n.d.). The Passivhaus standard

has also become a main building design standard for major cities in Germany, such as Frankfurt, (Laible, 2010a) and acted as an impetus supporting clusters of industries ,skills and innovations in specific areas. Despite the fact that it has moved from the innovator to the early adopter stage of development, it is still only a minority build standard in Germany and has taken in excess of twenty years to reach this stage of development.

It may be useful as part of further research to explicitly examine the processes which enabled the standard to develop to this level in Germany and other EU countries, but it would also be useful to understand and communicate findings from this process to enable a more rapid transfer of knowledge between countries where the standard is further advanced than in the UK. It may also prove useful and fruitful to explicitly examine the relevant legislative and cultural environment that has enabled this development in Germany. It could be argued that the successful development of the Passivhaus standard in Germany has been a result of a supportive evolutionary environment for this type of innovation as represented by the framework demonstrated by Speirs et al (Speirs et al., 2008a).

Process and Innovation

Examination of the findings from the case studies and Q-analysis feedback about the innovation processes outlined at the beginning of this research, may lead to the conclusion that many of the environmental structures described by Speirs et al (Speirs et al., 2008a) and Rogers (Rogers, 2003) as being necessary for the successful development of an innovation, are not currently in place to support the development of the Passivhaus standard in the UK.

Specific areas where support for innovation is shown to be different between the UK and Germany are in workforce skills as argued by Clarke and Herrmann (Clarke and Herrmann, 2004) who show that the UK has a less well trained construction industry base than Germany. Passivhaus also appears to be less well supported financially, for example from financial institutions such as the German state KfW bank, but also from legislation in the form of planning and building design regulations (which, unlike in Frankfurt or other European regions such as Vorarlberg in Austria (IgPassivhaus, 2013)) are not directly orientated towards the Passivhaus standard in the UK. There is also a lack of market accessibility to Passivhaus certified products in the UK combined with mainstream

acknowledgement of Passivhaus as a viable build standard. Currently the UK mainstream construction industry works with UK Building Regulations combined with the CSH and BREEAM. UK construction industry structure also does not a currently support a developed indigenous Passivhaus supply chain. This is demonstrated from the findings of the case studies, for example when architects had to develop their own products such as Passivhaus standard windows or import key components and expertise from abroad to deliver their projects.

Despite the fact that innovator pioneers have successfully delivered Passivhaus projects in the UK, (as demonstrated in the three UK case studies), recent research conducted by BRE and Leeds Metropolitan University raises concerns surrounding skills shortages in the wider construction industry ranging from client understanding through to site labour and even sales delivery teams. When referring to the development of highly and super insulated, near Passivhaus standard test housing at the BRE Innovation Park in Watford, BRE have stated that –

> *'All those building on the BRE Innovation Park recognised the need to address skills shortages in the industry. Design, site supervision and sales will all need to develop new skills to deliver these energy efficient dwellings to end users. Designers need to understand what to specify and which design combinations work best. Site supervisors will need to become project managers*. *Sales representatives will need to be able to explain technical information and data to buyers and how to use their new homes.'* (Gaze et al., 2008)

These recommendations are supported in the report '*Low Carbon Housing: Lessons from Elm Tree Mews*' (Bell et al., 2010) produced by Leeds Metropolitan University for the Joseph Rowntree Foundation from November 2010. They are complemented with further recommendations surrounding procurement and working methods. This report cites key lessons learnt from the project as being –

> *'**Procurement** – housing providers need to take more interest in energy and carbon performance of homes and in ensuring that claims made by designers, contractors/developers and suppliers are supported by robust evidence.*

> ***Design*** *– Design processes should be improved to: increase the robustness of detailed design, including thermal calculations; focus on as-constructed performance, taking into account component interactions in both fabric and services systems; give more consideration to the needs of households and provide resident friendly controls.*
>
> ***Construction*** *– Construction processes need to be improved so that: construction operations and sequences are planned in more detail and include in-production testing; changes during construction are closely controlled to ensure that performance is not compromised; the commissioning of services is more robust, ensuring that expected efficiencies and other operational parameters are realised.'*(Bell et al., 2010)

In conjunction to the above, the report recommends that -

> *'Developers and landlords should give more attention to the provision of meaningful guidance and support for residents.'* (Bell et al., 2010)

In the report '*Lessons from Stamford Brook'* produced by Leeds Metropolitan University and UCL, a large number of issues were raised as needing to be addressed to enable the delivery of low and zero carbon housing , these could be extended to include for the potential delivery of Passivhaus standard homes and buildings. Findings from this report include that the following changes to general construction protocol are needed -

> *'Rethinking the construction process, changes to the current Building Regulations, changes to the CSH, attention to buildability, the current UK supply chains, communication and overall process improvement and control.'* (Wingfield et al., 2007)

Of these issues, communication and project co-ordination can be noted as areas requiring considerable improvement in the construction process, particularly for the delivery of good thermal performance or energy performance of a building, but also the building fabric design-

> *'It is clear that there is considerable scope for improvement in the flow of information affecting thermal performance both upwards and downwards throughout the*

> *organisations involved whether developer, designer, subcontractor or trade. Very often design information affecting thermal performance was not available, not at the right level of detail, confusing or just not referred to by operatives. This led to a rather diffuse process as operatives followed their own judgement based on their trade skills and knowledge rather than using detailed design information.'* (Wingfield et al., 2007)

Therefore a lack of understanding of the processes surrounding the delivery of low energy buildings and/or the type of new design principles that may be associated with the delivery of the Passivhaus or 'zero carbon' buildings may be subverted if not correctly adhered to. This may have the potential result of the construction of developments which do not in practice meet the low energy criteria to which they were designed.

A symposium held at Westminster University on 05 November 2010 highlighted construction skills but also weak legislatory frameworks, fragmented industry structures and processes but also industry cynicism surrounding low energy building design as a key areas of concern when considering the delivery of the UK 'zero carbon' targets. The symposium titled '*Skills needs and barriers to zero emissions construction'* and included presentations by industry stakeholders involved in the production of and training for delivery of low energy buildings. A key presentation at this symposium was made by Linda Clarke of Westminster University who argued that –

> *'...a critical hindrance to the adoption of zero emissions construction is the problems associated with Vocational Education and Training (VET) and framing skills in UK construction. … construction VET in the UK is typified by a weak statutory framework, marginalisation of stakeholder interest, fragmented nature of skills sets, minimal underpinning knowledge, and functional skills provision rather than broad-based education'* (Clarke, 2010)

Robin Nicholson a Director from architects Edward Cullinan Architects and Chair of the Zero Carbon Task Force also conceded that

> *'… there remained a fundamental problem of 'silo-working' derived from the way professionals are currently being educated and suggested that there are insufficient numbers of environmental engineers being educated.'* (Clarke, 2010)

Richard Clarke who is the National Apprenticeships Officer at UNITE union maintained that there was a need to –

> *'co-ordinate rigorous and robust training provision and to institute contract compliance with regard to this'* (Clarke, 2010)

Richard Clarke was also concerned about the overall fragmented nature of current training provision. He felt that many product manufacturers are currently emerging simply to –

> *'profit from the low carbon and sustainability rhetoric'.* (Clarke, 2010)

A further seminar that was held on the topic of '*Skills for the Green Economy*' hosted by the Westminster Energy, Environment and Transport Forum at the College of Physicians on 21st October 2010, outlined the need to provide unprecedented levels of training to 'up-skill' our current workforce (Hames, 2010), if we are to meet the requirements of 'zero carbon' buildings targets and our national mandatory CO_2 reduction targets.

Also according to the Royal Academy of Engineering -

> *'Put bluntly, there are not sufficient of the brightest and best entering a career in the design of buildings as a system, and the systems within a building...small but important changes to the way engineering is taught can inspire the brightest and best to enter that field, and to become the inspirational leaders needed for the future. A key ingredient is to overcome the lack of people who can teach at undergraduate and postgraduate level in that field.'* - *Richard Haryott* (RAE, 2010)

The Passivhaus standard is at the very earliest stages of innovation in the UK with only a few finished accredited examples to act as precedent. Protagonists from the innovator group who participated in this research are however beginning to work to develop a UK Passivhaus culture and have shown that, even despite incumbent UK construction industry culture it is possible to deliver Passivhaus buildings in the UK. They have also shown the potential to deliver them at the same price as buildings designed using UK Building Regulations and

design standards such as BREEAM. The emergence of a Passivhaus culture in the UK can be seen with the development of the Passivhaus Trust and research and communication work that is currently being conducted by the Good Homes Alliance (GHA). They GHA are supporting the growth of a community of low energy house builders including those building to the Passivhaus standard (GHA, 2012).

Industries manufacturing Passivhaus products such as windows (as demonstrated in the case of Bere architects Passivhaus homes at Ebbw Vale in Wales) are also beginning to develop. If however these products and the future development of Passivhaus dwellings are to progress beyond the innovator community and into early adopter communities and to the mainstream, it will be necessary to stimulate a Passivhaus social and technological infrastructure and cultures. This must be combined with consumer demand so that Passivhaus is perceived as a desirable product by more mainstream protagonists and customers. This could partly be achieved through demonstration of products, such as finished buildings and the communication of precedent, but also through strategic skills training and education specifically targeted at individual groups within construction. Most importantly it should also be supported through legislation demanding the relevant increased standards in building fabric performance and testing. A failure to support this stimulation of demand and develop appropriate innovation strategies through financial, technical and social mechanisms that enable education and skills training, is likely to hinder the development of the Passivhaus standard and potentially lead to market failure or stagnation.

Complexity and Legislation

The UK is currently on a policy trajectory to deliver 'zero carbon' homes and non-domestic buildings, however original deadlines to achieve this are in dispute as is the definition of 'zero carbon'. This is despite copius work undertaken by the ZCH to provide an acceptable definition for legislators and the design and construction industry.

In conjunction with this changes in political landscape that have occurred after the most recent general election in the UK in 2010 have led to some industry concerns about continued government support for policy and mechanisms to deliver very low energy building designs. Shortly after the UK general election Grant Schapps, the Housing Minister

announced changes to housing policy with the launch of a statement at the National House Building Council on 25 November 2010 that -

> *'Housing Minister Grant Schapps today announced the scrapping of new proposals that could have cost developers thousands of pounds extra to build new homes, and pledged an overhaul of the complicated building standards that make it hard for developers to complete their projects. The Government will not introduce a new set of building standards that were proposed for many of the new homes built with Government funding or on public sector land, which would have cost developers an extra £8000 for every home.'* (CLG, 2010)

This resulted in some feelings of confusion in the construction industry when trying to understand new design parameters as emphasised in the editorial piece from the CIBSE Journal from April 2011 when Bob Cervi wrote –

> *'...a document published alongside the Budget details revealed an apparently significant backtracking by the government on its commitment to make all new homes 'zero carbon' from 2016. Although the details are not fully clear at the time of writing, it seems that ministers have effectively watered down the whole definition of 'zero carbon' by explicitly ruling out a household's use of everyday plug-in electrical appliances from the scope of the Building Regulations. Why? We can only assume that ministers are yet again kow-towing to the house building lobby – and thereby undermining Chancellor Osborne's claim to being the 'greenest ever'.'* (Cervi, 2011)

It is possible that the removal of household appliance electrical design loads from the Building regulations may lead to cases of overheating in newly designed buildings that have to comply with more stringent fabric performance standards. This is because the loads and associated heat emissions from these will not be accounted for in designs. It may also act to remove a facility for better understanding of energy use in the home and overall national energy demand requirements.

The Passivhaus standard specifically stipulates a limit for Primary Energy design for a building so as to work to limit a building's overall energy use, but also to impact on loads for space heating. A legislative move to exclude these electrical loads for domestic appliances

could work to deliver a message to the industry that these loads are not significant or important in a building's design when they are actually relevant to understanding the precise levels of design detail required for the delivery of Passivhaus and '*zero carbon*' buildings and need to be taken into account when designing with the Passivhaus Planning Package (PHPP).

Since the comments from Bob Cervi from 2011 the UK government has started to deliver intentions for in proposed changes to UK building regulations in 2013, these included –

- *'Deregulation and streamline wherever possible;*
- *Regulate only when essential and after all other approaches rejected;*
- *Deliver policies which support the desires of the greenest government ever; and*
- *Further improve compliance'* (Davies, 2012)

Whatever these policy intentions will actually entail, it may be argued that the final resolution of the debates and a progression towards the/an agreed '*zero carbon'* target requires a shift from the current paradigms towards a more rationalised and common solution. One that is workable as part of a consistent UK and European energy strategy, especially if the UK is to meet its 2050 80% carbon reduction targets (DECC, 2008).

It is clear from the above and the case studies that negotiating the legislatory interface parameters that are required to build to the Passivhaus standard in the UK add to the complexity of the delivery process. This is especially relevant if there are requirements for a Passivhaus building to also comply with the CSH or BREEAM.

The UK case studies show that it is possible for buildings to be designed to comply with dual standards but that this adds cost and complexity. It is also difficult to directly compare design compliance because of the different structures for adherence and the different energy calculation softwares that are used to meet each standard. SAP the UK design software for the CSH and SBEM which is used for BREEAM and UK Building Regulation compliance, aim for example, to show building energy design compliance with carbon/CO_2 as the dominant metric. The focus of PHPP is energy design in kilo-Watt hours per square meter. SAP also does not allow for the same level of sensitivity of design of many features as

PHPP, for example over-shading (therefore solar gain) from windows among many other factors. Other important differences include the use of German DIN Standard (now EU Norm) measurement methodologies for Passivhaus design as opposed to UK methods when measuring building floor areas and fabric design depth. This different approach to measurement is not necessarily complex to understand but is differet to the normal UK approach and has the potential to add confusion to calculation procedure, especially when UK building design and construction industry professionals are currently accustomed to UK measurement methodologies and criteria.

Of importance is the fact that the Passivhaus standard is currently relatively little known in the UK and is a foreign and foreign language standard (despite English language software being available). This means that there is currently limited support such as helpdesk support for the standard and PHPP in the UK. It also means that many construction industry protagonists inclusive of planning authorities do not currently understand the Passivhaus standard and may not have the appropriate skills to support it, especially if they may already been struggling with recent indigenous legislation as described in an article in the architecture magazine Building Design dated February 16 2007 –

> *'An exclusive BD survey has revealed a planning system in meltdown, with two out of three local authorities not ready to deliver the green homes promised by government.*
>
> *Just six weeks before the introduction of key legislation, the findings show huge inconsistencies across the country, alarming gaps in knowledge and skills and a feeling of impotence among planners, many of whom call for stronger guidance from central government'*

Evolution and Development

A strong component part of the opinion from the Q-analysis focuses on representation or a perception that the Passivhaus standard needs stronger representation in the UK and that there needs to be greater precedent and numbers of examples in the UK to learn from. Findings from research conducted as part of the Innovation chapter of this thesis suggests that learning is often best conducted between those from similar community groups, peer groups or cultures (Gladwell, 2001b) thus this would infer that those learning about the

Passivhaus standard in the UK might most successfully learn from indigenous UK projects and examples.

Since the start of this research in 2008, the number of accredited Passivhaus buildings in the UK has progressed from none to more than 24 and there are many more non-accredited examples and other developments currently in progress. These can potentially provide a palette for research and dissemination of understanding and help to increase awareness of the Passivhaus standard in the UK, particularly if consistent strategies are employed to disseminate findings and research information from these projects. A greater number of completed projects also have the potential to stimulate manufacturers towards R+D development and the production of UK Passivhaus certified components, especially if they start to see a market for these new products. Of importance for manufacturers is the existence of the certification process for the Passivhaus standard and components. This means that there are understood design parameters to which Passivhaus products must perform. This helps to creates certainty for manufacturers, customers, clients and insurers together with maintenance and facilities management providers and acts as the basis of a consistent QA (Quality Assurance) process. Likewise with a growing number of finished projects, potential clients and occupants have better opportunities to gain first had experience of Passivhaus buildings but also to understand that purchasing an accredited product can be understood to reliably perform to specific criteria.

The experience of Passivhaus in Europe provides a large body of evidence to substantiate actual performance of Passivhaus buildings and the findings from the CEPHEUS trials. The case studies included in this research show how, if designed and constructed in accordance with the specific requirements that Passivhaus buildings can perform well against designed energy performance criteria in use. This EU research has included for that recently carried out by Dr. Alexander G.Keul of the University of Salzburg, Department of Psychology within the framework of NaMap for Vienna's '*Residential Research Organisation*' (Keul, 2010b)(Trebesberg, 2009) in which POE/user-satisfaction surveys were carried out with 425 residents of Passivhaus private and social housing flats in Vienna. The occupants returned 225 surveys of which one hundred and fifty-six houses and apartments in Vienna were used as a statistical baseline for the research. Much of this research concluded positive user satisfaction and comfort levels in measured dwellings; however it must also be noted that

some user dissatisfaction was also documented. Likewise some user dissatisfaction was noted in the responses from the occupants of the two German case studies in relation to noise from MVHR installation. The exceptional thermal insulation of the Passivhaus buildings also leads to them being exceptionally acoustically sealed, with external noise penetration being reduced to very low levels. This fact was remarked upon by the residents of the KlimaSolarHaus in Berlin, but also from residents from the St. Jakob's project in Frankfurt. An acoustically sealed environment may be of advantage in busy inner city areas but could be an issue of concern for some occupants with acoustic contact to the external environment being blocked during times of the year when windows are routinely closed.

It is important to note that failure to construct Passivhaus buildings to specified levels of quality has the potential to result in the delivery of buildings that fail or do not perform reliably. This may result to inhibit interest in this standard and reduce market or mainstream confidence. When referring to the delivery of Passivhaus buildings, this would include for the accurate design and construction of all details and technologies such as MVHR. Of particular relevance to this theme is recent research conducted in the Netherlands into the installation and use of mechanical ventilation (which is a constituent part of Passivhaus design in the form of MVHR) in new dwellings. This has shown much negative satisfaction from occupants relating to this type of technology particularly in relation to poor indoor air-quality and poor quality installations. Balvers et al (Balvers et al., 2012)conclude that –

> *'In recent years nearly all newly built dwellings in the Netherlands have been equipped with mechanical ventilation systems. However many occupants of newly built Dutch homes seem to be bothered with draught heat, poor indoor air quality and lack of personal control of ventilation systems'* (Balvers et al., 2012)

Therefore any representation and communication of the Passivhaus standard in the UK needs to include for a greater understanding of relevant positive as well as negative examples and installations of technologies and construction design and implementation. Such representation also needs to include for feedback from overall construction processes and targeted dissemination of skills in the form of training and education to all parts of the

building design and delivery teams and feed-back systems, but also importantly to Passivhaus occupants and consumers. Of note here is that the success of the two German Passivhaus case studies used as part of this thesis can largely be attributed to high levels of occupant understanding and 'buy-in' to their Passivhaus projects. This is also reflected in the Denby Dale Passivhaus case study in the UK.

Additional Themes

The main focus of the findings from this research encompass the need for UK construction industry cultural change and the development of a specific Passivhaus culture and understanding of technologies such as MVHR, if the Passivhaus standard is to successfully develop in the UK.

Some key issues have not however been specifically covered as part of this research. For example all the case study projects and associated supporting UK research into low energy building design and delivery, together with the key factors of opinion from the Q-methodology research, focus on the design and delivery of new buildings. The majority of UK energy use in the built environment is however associated with existing buildings with the UK having a high proportion of old building stock. For example, according to '*The English Housing Survey Housing Stock Report 2008'* (DCLG, 2010) England has just over 21% of homes built before 1919 and just under 38% built prior to 1945 (DCLG, 2010). The importance and difficulty of refurbishing the UK existing housing stock to higher levels of energy efficiency, let alone to the Passivhaus standard, is discussed by Gavin Killip in his report '*Transforming the UK's Existing Housing Stock*' (Killip, 2008) for the Environmental Change Institute at Oxford University. The complexity and potential associated cost of refurbishment projects may act to deter the development of the Passivhaus Enerphit refurbishment standard for many existing buildings in the UK. This may also draw policy emphasis away from low energy building design and refurbishment towards delivery of other energy infrastructure mechanisms and solutions to achieve UK mandated carbon reductions. This however needs to be tested as part of further research.

In addition to this other themes not covered are the potential that the development of new technologies may have to positively influence the evolution of the Passivhaus standard in the UK. For example, within the realm of MMC such technologies such as 3D printing amongst others, together with domestic energy monitoring and control systems may have

the ability to support and speed up the delivery of the Passivhaus standard by facilitating better quality control and delivery of consistently designed products and design performance. Again, the impacts of new technologies on the development of the Passivhaus design in the UK would have to be tested as part of further research.

Another area not covered as part of the Q-methodology research or within the case studies relates to issues such as the typical size of new housing in the UK in comparison with other EU countries such as Germany or Scaninavian countries. According to research conducted by Rebecca Roberts-Hughes on behalf of the Royal Institute of British Architects (RIBA) in 2011 in her report '*The Case for Space: The Size of England's New Homes'*(Roberts-Hughes, 2011) the UK has the smallest new build housing in Western Europe.

> *'Through analysis of EU housing statistics in 2005, Policy Exchange and Localis found that new homes in the UK not only appeared to be shrinking, but were also the smallest in Western Europe. Consumers in Ireland could expect new homes to be 15% bigger, in the Netherlands they were 53% bigger and in Denmark, the average newly built home was 80% bigger than in the UK*' (Roberts-Hughes, 2011)

Designing to the Passivhaus standard potentially starts to become more complicated for smaller dwellings since while overall heat loads including those from appliances and other casual load gains can remain consistent in relation to occupant lifestyle and use, they can become relatively speaking higher per square meter, if they have to be contained within a smaller space/volume.

Conclusions

Despite the fact that the development of super insulated building design has its roots in the US, Canada and the UK over the past seventy years, this innovation has progressed further towards 'closure' in Germany in the 1990s with the development of the Passivhaus standard. This standard has developed in Germany, Scandinavia and mainland Europe through an early managed research process including POE monitoring and testing of inhabited projects. At the time of writing this thesis this process has extended over approximately twenty-two years was continuing to evolve and grow.

The process has allowed for the evolution of the standard, the recording of performance evidence and data and the development of entire Passivhaus technology clusters inclusive of skills, training, manufacturing industries and supply chains to support them. This evolutionary process of development has been possible through combined 'top-down' and 'bottom-up' dissemination processand has incorporated strategies involving the development of a Passivhaus movement and integration of stakeholders supporting specific product dissemination.

In the UK, despite growing numbers of examples, the Passivhaus standard is currently at the very early stages of innovator adoption and there are currently only approximately twenty four finished accredited examples (number recorded at the time of this research). This number is however ever increasing as the standard gains wider support. The UK case studies used as part of this research show that it is possible to successfully build to the Passivhaus standard, currently at least, on a small scale in the UK.

In parts of Germany and other EU countries such as Austria and Belgium the Passivhaus standard is now moving beyond the innovator stage of development and into early adopter and mainstream phases as it begins to be adopted as the regional build standard in many areas, for example in Frankfurt am Main where all new public housing must be built to the Passivhaus standard (Laible, 2010a). It can be argued that this has been the result of the managed development of the standard from small scale installations towards larger regional policy adoption.

There are currently more than about thirty thousand examples of Passivhaus buildings in mainland Europe (at the time of this research), predominantly in German speaking countries. Despite this growing number of developments, Passivhaus buildings still only make up a small proportion of all new build developments and the standard is not yet 'mainstream'. The number of developments is however rapidly growing due to increasing political, legislative and consumer support.

Small Innovators

In the UK, despite the involvement of large house building companies with exemplar low energy housing developments such as at the BRE Innovation Park, it has initially been individual innovative pioneers and not large mainstream UK construction businesses that have successfully delivered the first accredited examples of Passivhaus buildings. These small pioneers have taken steps and the risks to develop Passivhaus buildings and new products and skills to support the standard, when most large UK construction organisations have not. The small innovators have arguably paved the way for larger organisations to continue this development beyond the innovation stage of product evolution. A question that could be asked is why the larger organisations have not initially carried out the necessary research to develop buildings to this standard in the UK for themselves, or why they have apparently (at least partly) failed to learn how to deliver similar low energy buildings from previous examples of low energy super insulated buildings/dwellings in the UK? Perhaps this could potentially be linked to a lack of structured communication and/or dissemination methods employed by government bodies which could have provided this type of information? Further research would however have to be carried out to understand this.

Government Support

It must however be noted that the UK case studies used for this research were only possible because of some support from local government in the areas where they are situated. This type of support does not currently appear to be consistent throughout the UK and no specific financial aid mechanisms were provided to specifically support building to the Passivhaus standard. According to at least one of the Q-test respondents, the support of

local government for the development of Passivhaus buildings has even sometimes been quite negative.

Climate

The early UK Passivhaus case studies used in this research demonstrate that it is possible to build to the Passivhaus standard in the UK in different climatic regions. The German case studies also demonstrate the applicability of the Passivhaus standard for different climatic regions in Germany. Successful Passivhaus developments have also been built elsewhere in the EU and other countries with different types of climate zones such as in Japan, Italy and the US.

Skills

The case studies also demonstrate that it is possible to build to the Passivhaus standard in the UK using a variety of construction methods and using local contractors and designers. But there is still wide concern about the general quality of UK construction and design skills if the Passivhaus standard is to be delivered on a wider basis and by the mainstream construction industry. This is demonstrated in recent academic research conducted into the performance of low energy housing at Elm Tree Mews (Bell et al., 2010) and Stamford Brook (Wingfield et al., 2007) in conjunction with testing carried out at the BRE Innovation Park (Gaze et al., 2008) (Gaze, 2008) (Gaze and Clift, 2008) (Gaze et al., 2008). This highlights skills gaps in the mainstream construction industry which may hinder the successful delivery of low energy/super insulated housing in the UK. This is in part supported by the findings from the UK Passivhaus case studies which demonstrate that the delivery of a successful product requires a greater attention to design, detail and quality assurance than is frequently currently observed in much of the construction industry in the UK. This correlates with the assumptions made by the IEE in 2006, that construction skills are indeed a potential barrier to the uptake of the Passivhaus standard in the UK (IEE, 2006).

Current UK Legislation and Planning

The UK Passivhaus case studies demonstrate that it is possible to deliver new build Passivhaus projects on a small scale in the UK despite incumbent legislation and standards which do not fully support the Passivhaus standard. If it is considered desirable to adopt the Passivhaus standard as a build standard in the UK, these case studies positively demonstrate

that there is potential to combine the Passivhaus standard with indigenous UK legislation and standards. This is despite the requirements for compliance with UK standards and the Passivhaus standard being considerably different. The Passivhaus standard focuses on energy performance design criteria measured primarily in kWh and with fabric designed to very low levels of air-permeability, no thermal bridges and a requirement for MVHR. In comparison UK legislation uses carbon as a main compliance metric with less stringent requirements for fabric performance and air-permeability, it also employs the CSH (which is used alongside UK Building Regulations) and which places a greater stress on the use a suite of sustainability factors inclusive of materials and renewable energy technologies for compliance.

Findings from interpretation of the Q-factors reflects the opinions of early Passivhaus innovators in the UK that the Passivhaus standard is not currently well supported by UK design, planning and procurement systems and that a lack of UK precedent is inhibiting the understanding of the Passivhaus standard in the UK. Since these Q-tests were undertaken, the number of Passivhaus developments has increased together with awareness of the Passivhaus standard in the UK. This shows that with the enough motivation and positive intentions it is possible to deliver Passivhaus projects in the UK even despite the existing legislative environment. But unless the standard gains wider political support, it will probably only to continue to exist amongst pioneers and enthusiasts or innovators.

MVHR

Other factors of opinion from the stakeholder group focus on a lack of understanding of design, installation and operation of MVHR. This is also supported by wider UK research and that recently conducted in the Netherlands which emphasises a need for greater understanding of mechanical ventilation technologies, if they are to be more widely used and accepted, particularly as part of domestic building design. Of relevance to this are the findings from the German case studies which show that occupants of these developments have had to learn to live in their Passivhaus homes and that this has included learning to understand how to operate their MVHR systems and control thermal comfort via appropriate opening and closing of windows and use of solar shading. In conjunction with this some questions have been raised about the quality of MVHR installation and acoustic

and/or indoor air-quality problems that may be associated with incorrect, non-maintained or poorly understood installations. These issues are demonstrated in some UK and European projects that have either employed MVHR or mechanical ventilation. This is reflected in recent research undertaken in the Netherlands from van Hall (van Hal, 2000),van der Pluijm (van der Pluijm, 2010) and Balvers et al (Balvers et al., 2012).

Products

The findings from the UK case studies demonstrate gaps in the market for provision of appropriate components to support the Passivhaus standard and low energy building design. This means that those currently wishing to build to the Passivhaus standard in the UK may need to import products from the EU at extra expense. The lack of indigenous certified component parts available may also potentially indicate an associated lack of skills to support the installation of such components. This could be represented by the fact that Bere architects employed German manufacturers to demonstrate the installation of their Passivhaus certified windows to a Welsh construction team at Ebbw Vale (Lynch, 2011a) but also the findings from the study of a Passivhaus refurbishment Enerphit project undertaken by Orbit Housing, presented by John Barnham at an event hosted by the GHA at UCL on 26th April 2012 (Barnham, 2012). This demonstrated a need to use German Passivhaus components combined with technical maintenance support from German manufacturers and contractors for success of their project.

Research

In conjunction with this it is apparent that there is an increasing and significant body of research surrounding the Passivhaus standard, components and Passivhaus developments around the world which is not currently permeating the mainstream UK construction industry. This means that UK industry is currently not generally learning from this research, despite some individuals gaining insights from it. This thesis also argues that the UK construction industry has not widely learnt from indigenous research carried out over the last decades into low energy building design, with communication of this research often being unstructured or fragmented. It also suggests that the adoption of the EPBD (which stimulated the development of the CSH and evolution of UK Building Regulations Parts L and F) has worked to trigger most recent changes in legislation and design standards in the UK

aimed at supporting low energy building design inclusive of, a revival in interest for super insulated building design and uptake of the Passivhaus standard by some.

A lack of learning from past low energy super insulated buildings in the UK means that without 'up-skilling', much of the UK construction industry may not currently be best placed to successfully deliver the low energy/carbon buildings required for 'zero carbon' targets. The UK case studies do however show that there is the potential to learn how to do this. This could take considerable time, considering the apparent scale of training and understanding required and the current lack of provision for this. How such skills training could be provided would have to be understood as part of further research.

Some of this 'skills learning curve' could however potentially be compensated for with the use of new innovative off-site, MMC (Modern Methods of Construction) technologies, with specific components or entire buildings being designed and constructed in factories. Again such potential would have to be tested with further research.

Cost

The UK Passivhaus case studies have shown that it is currently possible to deliver a Passivhaus and UK legislation compliance building, as demonstrated in the Canolfan Hyddgen, for the equivalent price to a building constructed only to UK BREEAM Excellent requirements. The other two UK case studies were however delivered at extra capital cost. This is consistent with general findings from early German Passivhaus buildings and those being constructed in Germany and other parts of Europe today.

Cost uplift in the UK and elsewhere is generally attributed to additional R+D and the learning curves associated with the design and construction together with a lack of indigenous UK Passivhaus components. Extra costs were also associated with extra care needed on site to deliver the more exacting fabric performance and the processes surrounding design compliance with dual standards where applied.

The uplift in capital cost largely correlates with findings from the Passivhaus Institut in Darmstadt when considering the development of Passivhaus projects in mainland Europe, but does not take into consideration the potential savings through reduced energy use over time and whole life costing. Capital costs are however a specific issue, especially if building

'first-time' Passivhaus projects in cities with high land costs such as London. This has been demonstrated in the German case studies in Frankfurt and Berlin, where these costs were offset and the projects were in part possible due to 'support' in terms of low or subsidised land costs.

Performance

The Passivhaus standard has a substantial proven record of performance, mostly from developments in mainland Europe. This is demonstrated in extensive POE research from inhabited projects, with methodologies employed that have often been more expansive than those used to test similar low energy buildings in the UK, for example the exemplar super insulated CSH dwellings at the BRE Innovation Park, which informed the development of the UK CSH and Building Regulations and further iterations of the CSH post 2006. Further POE research and monitoring of CSH housing is however being conducted as part of the Technology Strategy Board (TSB), Building Performance Evaluation Programme (BPEP) with the aim of this being used to feedback into future UK building design legislation.

Zero Carbon

This research suggests that the Passivhaus standard has the potential to offer an appropriate solution to meet UK 'zero carbon' building targets, especially considering its proven performance which includes for research that argues that building to the Passivhaus standard using MVHR has been shown to be less carbon intensive than building to the same fabric performance but using natural ventilation (AECB, 2009). This is assuming for the fact that Passivhaus fabric performance specifications are met and MVHR is correctly designed and installed. This is relevant when comparing the Passivhaus standard to the CSH since the air-permeability and fabric design targets for high levels of the CSH are not as robustly consistent as for the Passivhaus standard. This could result in unintended energy in use for buildings designed to CSH levels of performance.

Building to the Passivhaus standard could present a cost effective option for the delivery of the basis of 'zero carbon' buildings since cost uplift for the delivery of a Passivhaus project does not appear to exceed current estimates of about 15% for the delivery of a CSH level 5 home as demonstrated in research conducted by the GHA for the CLG (DCLG, 2009). Use of

the Passivhaus standard for the delivery of 'zero carbon' homes would allow for energy loads to be reduced to a minimum prior to the integration or interface with renewable energy technologies as appropriate and viable. This would however have to depend upon government support to clarify strategic target parameters and frameworks for the delivery of 'zero carbon' buildings.

Development

The growth in development of the Passivhaus standard in Germany and the EU is working to stimulate the development of supporting industries and skills and the manufacture of Passivhaus certified components. It is also potentially working to stimulate quality assurance in construction, since the processes surrounding the delivery of a Passivhaus building demand special care and attention to details and greater team co-operation than might normally be associated with much traditional building procurement.

The response of and feedback from occupants and consumers will be of great importance if the Passivhaus standard is to successfully develop in the UK, according to Cole et al (Cole et al., 2010)

> *'Inhabitants are recognised as one of the best instruments for measuring housing performance, even if they are hard to calibrate'* (Cole et al., 2010)

Despite the recent development of TSB BPE programmes, according to Stevenson and Leaman in the Journal Building Research and Information Editorial; Evaluating Housing Performance in Relation to Human Behaviour: New Challenges -

> *'Curiously, there are currently no UK government policy requirements for POE as part of its strategy to reduce carbon emissions in housing. This means that little real feedback exists on how housing is performing during occupation, which makes it difficult to ascertain whether targets are being achieved in reality, whether the design, procurement, and management strategies are actually working and whether occupants are actually reducing their demands and expectations (particularly in relation to so-called 'efficiency gains') (Leaman and Stevenson)*

Feedback from building occupants can be vital to gaining an understanding of how a building functions. In addition to this feedback from the design and construction processes, together with energy and environmental monitoring also need to be provided for a true evaluation of the success of a building and the processes surrounding its delivery. It is frequently the human and management processes, rather than technologies in themselves that can lead to failures in a procurement system, during design, construction and/or maintenance.

This is demonstrated in research undertaken by Anke van Hal into a number of European low energy housing projects, documented in '*Beyond the Demonstration Project: The Diffusion of Environmental Innovations in Housing* (van Hal, 2000) these findings argue for a need for strong clear and co-ordinated project organisation and management processes if developments are to be a success. This includes for participation of relevant stakeholders, (inclusive of occupants), at the earliest appropriate stages in the project design, but also appropriate levels of background research, adequate finance and clear networks and structures of communication. The following excerpt from van Hal's research refers to some experiences surrounding the integration of different stakeholders in a housing project and the importance of their early involvement but also some of the 'political' issues that can arise as part of such a process-

> *'The importance of early involvement is apparent, also by the fact that the utilities companies sent in their own electricians too late, which makes complications of the chosen system not recognised early enough. However, early involvement of all parties can also have disadvantages. In this case the voice of the residents was so well arranged that apparently these became indignant when (detailed) decisions were made without them'* (van Hal, 2000)

The research work of van Hal also correlates with findings from Balvers et al (Balvers et al., 2012) in their review of mechanical ventilation in recently built dwellings in the Netherlands. This research refers to the importance of process and communication for the successful delivery of designs that include mechanical ventilation strategies. It also concludes that there needs to be a greater understanding of how mechanical ventilation technologies are

designed, installed and used by occupants if they are to be effective in mainstream housing developments. This is particularly relevant to installations in refurbishment projects which by their nature are complex and idiosyncratic due to the varying design and condition of existing buildings. This is demonstrated in the findings of the UK DCLG in their report '*The Retrofit Challenge: Delivering Low Carbon Buildings'* (Stafford et al., 2011) –

> '*Each house is different, so there is no 'one size fits all' solution: householders and building users have different attitudes to, and understanding of, energy efficiency. Installers do not all have the necessary skills to fit more advanced energy efficiency and renewable energy measures'* (Stafford et al., 2011)

It would be useful to consider these findings and those from Leaman and Stevenson and van Hals if the Passivhaus standard is to progress to wider dissemination in the UK.

To conclude, the findings from the small number of UK case studies show that it is possible to successfully build to the Passivhaus standard in the UK in different climatic locations and using different construction types. These case studies act as a precedent to prove the viability of Passivhaus construction in the UK. There are however many cultural and socio-technological issues, inclusive of the provision of skills and development of QA and management processes that need to be provided and resolved if the standard is to progress beyond the early innovator stage of adoption and into the mainstream.

Findings from the Dutch case studies from Balvers et al and additional UK research together with the findings from the Q-analysis draw attention to specific design issues inclusive of an understanding of design and installation and use of mechanical ventilation/MVHR as being key weaknesses that need to be addressed if the Passivhaus standard is to be successfully delivered to a wider market.

Development of the standard would also be well supported through greater communication with countries such as Germany where the standard is better developed and learning from the lessons of early developments in these countries where evolution of the standard has focused on the development of the standard from the small local to the larger scale. Also of importance would be a greater understanding of innovation processes as outlined by Rogers (Rogers, 2003) Speirs (Speirs et al., 2008b), Foxon (Foxon et al., 2005b) and Brand (Brand,

2005) that show the importance of an awareness and implementation of 'whole system thinking' for success. This would include for the social integration of new innovations from both 'top-down', 'bottom-up' and product dissemination perspectives combined with the implementation of R+D and testing strategies and appropriate financial support mechanisms. This 'whole system thinking' could include for monitoring and POE of buildings, the use of case studies as precedent and the assessment of project management and construction processes. These could all have the ability to provide invaluable feedback that can potentially help to deliver successful future projects and prevent costly design and construction mistakes.

The results of testing of many Passivhaus projects in Germany and mainland Europe including the findings from the CEPHEUS programme and the two German case studies used in this research show that the Passivhaus standard has the potential to consistently deliver very low energy performance buildings. If the Passivhaus standard is however to form the basis of '*zero carbon'* buildings in the UK as Passivhaus supporters in this country believe and the UK case studies in this thesis show the potential for, then cultures to support the standard needs to be developed in the UK.

The beginnings of such a 'Passivhaus culture' are beginning to emerge but this would need to evolve considerably to include for the development of skills training, education and awareness across the entire construction industry together with increased awareness and understanding from consumers, if the standard is to be more widely adopted. In this respect the German case studies may show potential approaches to occupant/consumer engagement that could potentially be replicated in the UK as the standard progresses here. Likewise much could be learnt from approaches to implementing the standard in a more managed and staged way allowing for the development of technology clusters in specific areas.

Except on a marginal basis, the Passivhaus standard is not however currently supported by indigenous political policy and legislation in the UK. Taking this into consideration, it is unlikely, with the exception of a minority of projects, that it will be developed and used by mainstream designers, developers and contractors as the basis to meet either of the original UK '*zero carbon'* targets outlined in 2006 for '*zero carbon'* dwellings in 2016 or non-

domestic buildings in 2019. In conjunction to this there is some doubt as to the potential for current UK construction industry culture to consistently deliver the UK policy requirements for '*zero carbon*' buildings, especially when considering that there is some continued debate about the definition of the term '*zero carbon'* and/or proven and consistent methods for delivery. This is combined with research findings that currently show inconsistencies in many of the design, management and quality control mechanisms surrounding the delivery of low energy and CSH buildings. There is however great potential for the construction industry to learn how to deliver Passivhaus and very low energy buildings as long as clients, designers, contractors and occupants have the desire to do this. This process would however probably best be supported by government with consistent and strategic delivery plans.

Opportunities

Despite the fact that there are currently many barriers inhibiting the uptake of the Passivhaus standard in the UK, there may also be many opportunities. The following is a list of some suggested measures that if put in place, could potentially help to stimulate the development of the Passivhaus standard in the UK, thus helping to take it beyond the innovator stage, through to early adopter uptake and eventual mass market adoption. This list is not conclusive.

- *The development of a strategic plan to communicate the Passivhaus standard to cross-industry sectors and stakeholders:* According to Moore in 'Crossing the Chasm' (Moore, 2007) new innovations are best marketed beyond the early innovation stage and to the mainstream through the targeting of a specific market group or niche using the strategic processes of '*Whole Product Planning'* (Moore, 2007) this also links to the findings of Rogers in the 'Diffusion of Innovation' when he describes the need for an understanding of the wider social and communications contexts surrounding the development of an innovation together, with the support of technical development and relevant affiliated industries, inclusive of training, education and product support, if a product is to be a success.

- *Since Passivhaus is a tried and tested standard, allow those who wish to build accredited Passivhaus buildings in the UK to be exempt from compliance with Building Regulations Parts L and F and the energy design parameters of BREEAM and the CSH: as appropriate:* The fabric performance criteria for the Passivhaus standard exceed the requirements of UK Building Regulations part L 2010/13 and are more consistent than the requirements for CSH level 6 or the highest levels of BREEAM performance, therefore current UK 'zero carbon' parameters. The Passivhaus standard also requires lower levels of ventilation in comparison to current UK Building Regulations part F. These ventilation levels correspond to requirements that allow for the efficient functioning of MVHR which is a prerequisite of the Passivhaus standard to be met. Considering the fact that the Passivhaus standard has been developed through testing over the past twenty years and has shown consistent high

levels of performance in energy efficiency, it should not be necessary for those building to this standard to comply with less onerous regulations such as the CSH or Part L since this will add unnecessary extra cost and complexity to developments. However given the results of recent research undertaken in the Netherlands into the installation and use of mechanical ventilation, particular focus may need to be applied to addressing the complexities surrounding the design, installation and use of this technology.

- *Allow those building to the accredited Passivhaus standard in the UK to be viewed positively from a planning perspective:* The results of the Q-analysis and a quotation from at least one of the respondents appears to show that the Passivhaus standard is currently not well understood by planners in the UK, thus planners do not necessarily currently look favourably on Passivhaus projects or easily grant them planning permission. This could potentially result in problems of delivery and incur extra costs for Passivhaus projects seeking planning. Planning support of Passivhaus developments would also enable more Passivhaus buildings to be constructed together with the associated development of construction and designs skills and supply chains.
- *Provide financial incentives such as low interest loans offered by the kfW Bank in Germany to those building to accredited Passivhaus standard in the UK:* Usually there are additional costs associated with building to the Passivhaus standard. This is still the case in Germany where the Passivhaus standard has been part of building design standards during the past twenty years. The provision of low interest financial incentives could therefore help those to build to the Passivhaus standard especially if they are not able to afford the extra associated costs.
- *Provide financial incentives such as low interest loans offered by the kfW Bank in Germany to those developing Passivhaus accredited products, education and supply chains:* If the Passivhaus standard is to be widely understood and cost effective in the UK then skills training and the development of Passivhaus products needs to be financially supported. There are additional costs associated with their development which may not be able to be supported by industry without financial incentives especially at the initial stages of development. Support for new 'green' industry in this area may also have the potential to stimulate the wider economy.

- *The development of greater knowledge transfer links for building design and construction between Germany and other EU countries and the UK:* Germany, Austria and many other EU countries have more experience of building to the Passivhaus standard than the UK, it would therefore make sense to learn from their experience by increasing knowledge transfer from countries and organisations that have already gained experience, rather than learning everything new and potentially repeating mistakes.
- *Allow for co-evolutionary strategies to play a greater part in the development of building design legislation and the Passivhaus standard in the UK:* Some of the earliest Passivhaus projects in Germany, inclusive of those used as case study examples in this thesis, have employed co-evolutionary strategies for their success. This has meant that they have used social development techniques alongside technologies, allowing people (inhabitants and building designers/contractors) to work together with new innovation to help ensure it is understood and correctly implemented. This has allowed building occupants/designers to gain a greater understanding of their new developments than is normally the case. This creates occupant buy-in and trust, together with an understanding of technologies that can potentially help to prevent costly failures. Co-evolutionary strategies should also extend to the teaching of Passivhaus design principles to designers and contractors but also public awareness training.
- *Future development of building legislation and standards should take greater account of monitoring, POE testing and expert evidence to support its development:* Without feedback in relation to building performance it is difficult for designers, clients and occupants to learn from positive and negative aspects of a design. The early Passivhaus developments at Kranichstein and the CEPHEUS programme successfully used extensive monitoring and POE as part of the processes involved in the development of the Passivhaus standard and the PHPP software. This testing has arguably produced a robust design standard that if implemented correctly has the capacity to consistently provide low energy buildings. The same degree of testing and monitoring was not carried out prior to the launch of the CSH to the UK mainstream construction industry.

Limitations of Research

This research provides a 'snap-shot' of the opinions from an early pioneer group of Passivhaus innovators in the UK together with the findings from three early Passivhaus developments in the UK and two in Germany, as such the scope of this research is limited. This 'snap-shot' approach does however have the capacity to offer some potential insights into the understanding of the respondent group. The findings from the case studies could also help to provide indications for future areas of study and themes that may be relevant to the mainstream construction industry when considering the development of the Passivhaus standard. Snap-shots can however, as argued by Malcolm Gladwell in his book '*Blink*: *The Power of thinking without thinking,'* (Gladwell, 2006) be of great value since they can allow for subjective impressions, which contain a large amount of information stored in the subconscious to be incorporated into a '*thin slice*' or map/pattern of a subject area. The use of Q-methodology has allowed for a similar type of 'thin slice' approach which has been integrated into this research, but using the opinions from a group.

Further key limitations to this research are that it largely only reflects the opinions of the respondent group involved and the findings from individual case studies. It does not therefore reflect opinion or findings from the wider construction/consulting industry or those building Passivhaus developments in the UK since this research was undertaken. The research methods by nature confine this research to a review of opinions from a small group and a small, but significant, number of case study examples conducted during the time-scale of this research.

The research may however work as an indicator to outline some of the main barriers and opportunities surrounding the early development of the Passivhaus standard in the UK. It may also help to suggest potential themes and areas of relevant consideration for extended or further study with these potentially employing different or larger appropriate groups of respondents and case studies.

Other limitations lie in the 'snap-shot' nature of the research which captures opinion and context from only a particular point in time. Since conditions, context and opinion are liable to change, so might the results of a similar piece of research conducted at another time. It

must however be noted here that the 'opinion' correlates well with findings from the case studies.

The use of Q-methodology and analysis also has limitations in that results are influenced by the mood and opinions of respondents attending focus groups at that moment in time, together with the mood of respondents undertaking the Q-tests. The Feminist nature of this research has meant that on occasion, focus group research has also included for the opinions of the researcher who forms part of the group of early Passivhaus innovators in the UK, as has the interpretation of the results.

It is likely that if focus groups and Q-tests had been undertaken at different times during this research then there may have been a slight variation in the outcome to the results. This is however partly compensated for through the use of more than one focus group and the use of literature to form the basis of the Q-concourse and the mixed methods approach to research which allows results to be cross-referenced / triangulated.

The stakeholder group represented in this research was also limited by those who were available and willing to participate. The respondents did however make up a large proportion of those involved in Passivhaus design and innovation in the UK at the time of research. Since the start of this research the number of people involved with Passivhaus design and innovation in the UK has however grown. If this research were to be completed now or in the near future it may be useful and necessary to extend the boundaries of the community involved.

The case studies are in part limited by their individual nature and no specific POE studies were carried out with occupants of the UK case study buildings in the same way that were conducted with the German Case Studies. It may therefore be useful in future research to conduct similar studies with UK Passivhaus occupants. The German POE case studies were also limited by the number of occupants who could be interviewed and the short time-frame in which they were conducted. It may also be useful to extend this study to more of the occupants of these dwellings and to additional buildings in Germany and elsewhere in the EU, but also to include information gathered from energy metering and monitoring to compare this with occupant feedback.

In addition to this it may be useful to compile an extended study of further new and refurbishment Passivhaus buildings in the UK to gain further data and understanding as to their construction, viability and performance, but also to look at the use of different type of materials for Passivhaus construction and potentially also ventilation strategies.

Overall this research acts to provide a narrow but in-depth view of a specific subject, taking into consideration the time parameters surrounding the research and its limitations.

Further Research

Given the nature of this research which offers a 'snap-shot' view of the opinions of early Passivhaus adopters and findings from early Passivhaus case studies in the UK, the findings and conclusions provide some answers in themselves but also start to pose questions for further research. Suggestions for future research are listed below according to theme.

All themes could be covered in simultaneous research since all are intrinsically linked and relevant to the understanding of and the dissemination of the Passivhaus standard in the UK. Research could result in the production of communication information about the Passivhaus standard including translation of existing German research and the production of educational films together with overall education, training and skills reviews. It could also include comparisons between UK and German political policy supporting the development of Passivhaus. This additional research could also support key findings from this thesis research which suggest a lack of communication about the standard and education and skills gaps supporting Passivhaus in the UK, but also UK political systems that do not currently or coherently promote development of the standard well.

Translation

- Translate all key Passivhaus literature into English: Currently the majority of the research literature surrounding the Passivhaus standard only exists in German a greater understanding of the standard could be increased through the translation of this material into English.

Communication

- The production of a series of OU (Open University), or similar documentary films about Passivhaus case studies: Film documentaries could have the capacity to introduce the concept of Passivhaus to a wider audience outside of construction and construction design thus helping to improve communication about the standard to the general public/main stream customers who do not currently form part of the UK Passivhaus community.
- The production of a series of training films - how to design, build and live in a Passivhaus: Film has the potential to be a very democratic method for quickly

conveying consistent information to large numbers of people. Film could be used as a medium to demonstrate skills and techniques to designers and contractors without them having to directly observe processes on site, which is not always a possibility, especially if processes are happening in different geographic regions or countries. Film also has the potential to be used as a manual to show people how to operate and maintain a building or components in a building.

- The development of better construction trade and educational links with Germany and other EU countries: This research starts to show higher levels of construction skills training in Germany couple with a greater number of Passivhaus developments. If the standard is to progress in the UK, it may be useful to learn from Germany and other EU countries where the standard is more advanced to increase knowledge and understanding. In the Case of the Larch House at Ebbw Vale, Bere Architects successfully employed German manufacturers to demonstrate how to install a Passivhaus window.

Political and Dissemination Process

- A review of the policy processes and outcome for the delivery of Passivhaus buildings in Frankfurt – what can the UK learn from this?: The UK works with a different policy framework and legislation in relation to building design than Germany or other EU countries. To date German speaking countries have been more successful in the delivery of Passivhaus buildings than the UK, it would therefore be useful to understand what differences in policy surround the development of the Passivhaus standard in Germany in comparison to the UK.
- The development of a dissemination strategy for Passivhaus in the UK.

Skills, training and Education

- A review of architecture and engineering training in the UK and its capacity to deliver Passivhaus and '*zero carbon*' buildings: Findings from this research indicate that it has been a small group of pioneers and not the main stream construction industry that has been responsible for the delivery of the earliest accredited Passivhaus buildings in the UK. If this standard is be employed by main stream industry it would

be appropriate to check the capacity of the training of key consultants, such as architects and engineers to deliver it.

- A review of the mechanisms to support the development of construction skills to enable the delivery of high performance building fabric: High performance building fabric is vital for the delivery of buildings to the Passivhaus standard.
- A review of PHPP and PHPP users in the UK and Germany: PHPP is not a standard building design software in the UK and it uses different metrics to those commonly used for building design in the UK. This may make it more difficult for some UK designers to use, in conjunction to this at least one respondent from those interviewed felt that it was actually quite complex to use. A review of how the software is used and understood in both the UK and Germany could potentially help improve or develop it to make it more 'user' friendly, therefore better enabling the design of Passivhaus buildings in the UK.
- A review of UK skills training and its capacity to deliver Passivhaus and '*zero carbon*' building design: The UK Passivhaus case studies demonstrated that it is possible for UK architects, engineers and contractors to build to the Passivhaus standard in these particular cases. However evidence from the BRE Innovation Park and other low energy building design projects in the UK have recently demonstrated that lack of construction skills seems to be an issue when trying to deliver more air-tight buildings. If the Passivhaus standard in the UK is to be successful it is arguable that it is in large part reliant upon the skills of those constructing the buildings. The issue of skills is also highlighted as a potential barrier to the uptake of Passivhaus design in the UK by the IEE (IEE, 2006) and the research of Linda Clarke and George Herrmann (Clarke and Herrmann, 2007) highlights lower levels of construction skills training in the UK than in Germany.
- A review of UK mechanisms supporting MVHR design and installation training: Installation of and use of MVHR systems and availability of very efficient MVHR units suitable for use in Passivhaus buildings appear to be potential barriers to the uptake of the Passivhaus standard in the UK. This is demonstrated by the UK and German case studies and also the results of the Q-methodology analysis.

Procurement and Supply Chain

- A review of UK construction procurement processes in relation to delivery of Passivhaus and 'zero carbon' buildings: Despite the fact that the UK case studies used for this research were delivered using UK procurement methods, these case studies are small and do not necessarily reflect the typical methods by which mass market buildings are delivered. It may therefore be useful to test the delivery of the Passivhaus standard against procurement methods such as 'Design and Build' which are commonly used for larger scale developments.
- A review of UK supply chains capacity to deliver Passivhaus and '*zero carbon*' building design: The lack of specific Passivhaus components such as windows, efficient MVHR systems and other items appear to a key barrier to the uptake of the Passivhaus standard in the UK. A review of supply chains and their potential to deliver Passivhaus products may help to understand gaps in the market.
- A review of the capacity for new MMC technologies and building control systems to deliver Passivhaus buildings in the UK.
- A review of the capacity for low impact construction materials and alternative ventilation strategies to deliver the Passivhaus standard.
- A review into the potential to deliver Passivhaus co-operative/co-housing in UK cities: The German Passivhaus case studies used in this research were both delivered as co-operative/co-housing developments and appear to owe much of their success to this fact. This type of model for delivery of housing is less common in the UK but may offer a viable approach to the delivery of sustainable, low energy housing in the UK.

Extended Case Study Research

- Research into and collation of further UK Passivhaus case studies inclusive of refurbishment projects: The example Passivhaus case studies used for this research include some of the earliest examples of accredited Passivhaus buildings in the UK, further research would benefit from the review of more UK case studies to gain a greater understanding of issues presented in their design and construction.

Extension of Q-methodology Research

- Repeat the Q-process with relevant UK Passivhaus stakeholders after 2012: Since the start of this research the number of protagonists involved in the development of Passivhaus building design and consultancy has increased. Q-methodology analysis undertaken with respondents from this larger group could offer a more balanced selection of professions involved together with their opinions. For example consultants such as quantity surveyors but also Passivhaus residents could be included.
- Repeat a similar Q-process with residents of German and other EU Passivhaus developments, thus gaining a broader spectrum of opinion surrounding the issues that may surround living in and procuring a Passivhaus development.
- Update PQ software: Currently PQ software exists in DOS format it may be useful and appropriate to upgrade this to a more user friendly platform to allow greater and easier use.

Development of POE Research

- The development of an EU POE conference: The EU wide CEPHEUS programme was vital to the development of the Passivhaus standard and has set the precedent for the continued POE assessment of many Passivhaus building in Europe. Currently no specific POE conference exists in the UK. A POE conference could increase communication between those designing low energy and Passivhaus buildings and
- A national POE database from occupants of UK Passivhaus projects: The production of a UK Passivhaus POE database would provide material for research and greater understanding of performance of Passivhaus buildings in the UK.
- Promote the value of POE and increase understanding of building performance.

Postscript

Since undertaking this initial research the number of Passivhaus developments and size of the Passivhaus community in the UK has continued to grow. This has led to an improved skills and knowledge base surrounding the standard.

However the standard and its dissemination still sit at the early innovator stages of development and the periphery of mainstream construction. Without strategic political and educational support, the standard may remain at this level or take many years to reach similar levels of adoption as in Germany or other EU countries which are now moving into and beyond early adopter phases of development. These countries may be looking to capitalise on this development and export an entire industry to the UK, political will allowing.

Glossary

AECB – The Sustainable Building Association

ASHRAE - The American Society of Heating, Refrigerating and Air-Conditioning Engineers

BBC – British Broadcasting Corporation

BEMS – Building Energy Management System

BGCBC – Blaenau Gwent County Borough Council

BPEP – Building Performance Evaluation Programme

BRE – Building Research Establishment

BREEAM – Building Research Establishment Environmental Assessment Method

BSRIA – Building Services Research and Information Association

CAT – Centre for Alternative Technology

CEPHEUS – Cost Efficient Passive Houses as European Standard

CIBSE – Chartered Institute of Building Services Engineers

CO_2 – Carbon Dioxide

CHP – Combined Heat and Power

CSH – Code for Sustainable Homes

DER – Designed Emissions Rate

DCLG (CLG) – Department of Communities and Local Government

EBÖK – Ingenieurbüro für Ökologische Konzepte

EnEV - Energieeinsparverordnung

EnerPhit – Energy Standard for Passivhaus Refurbishment

EPBD – Energy Performance of Buildings Directive

ERDA – US Energy and Research Administration

EU – European Union

GHA – Good Homes Alliance

GLS – Gemeinschaftsbank für Leihen und Schenken

HMWT – Hessischen Ministerium für Wirtschaft und Technik

IEE – Intelligent Energy Europe

IWU – Institut für Wohnung und Umwelt

KfW - Kreditanstalt für Wiederaufbau

kWh – Kilowatt –hour

LA – Local Authority

MMC – Modern Methods of Construction

MVHR – Mechanical Ventilation with Heat Recovery

OU – The Open University

PCC – Powys County Council

PHI – Passivhaus Institut

PHPP – Passivhaus Planning Package

PHT – Passivhaus Trust

POE – Post Occupancy Evaluation

QA – Quality Assurance

RAE – Royal Academy of Engineering

RIBA – Royal Institute of British Architects

R+D – Research and Development

SAP – Standard Assessment Procedure

SBEM – Simplified Building Energy Model

SHC – Small Homes Council

TAS – EDSL software for building energy modelling

TER – Target Emissions Rate

TSB – Technology Strategy Board

UCL – University College London

WAG – Welsh Assembly Government

ZCH – The Zero Carbon Hub

Bibliography

AECB, 2008. Projecting Energy use and CO2 emissions from low energy buildings. A comparison of the Passivhaus Planning Package and SAP. AECB.

AECB, 2009. Comparing Energy Use and C02 Emissions from Natural Ventilation and MVHR in a Passivhaus House: A CarbonLite Information Paper. AECB.

AECB, n.d. AECB Carbonlite.www.carbonlite.org.uk.(accessed 15 March 2012)

Baekeland, L.H., 1916. . 'Practical Life as a Complement to University Education – [Perkin] Medal [Acceptance] Address. '. Journal of Industrial and Engineering Chemistry 184–190.

Bailey, C., 2009. Learning from Passive Action. CIBSE Journal 1, 29–31.

Balvers, J., Bodgers, R., van Kamp, I., Boerstra, A., van Dijken, F., 2012. Mechanical ventilation in recently built Dutch homes: technical shortcomings, possibilities for improvement, perceived indoor environment and health effects. Architectural Science Review 55.

Barnham, J., 2012. Sampson Close and Elliott Drive, Orbit Heart of England, in: Case Study 1: Passivhaus and Existing Stock -. Presented at the Low Carbon Homes for Real: Part L compliance and proof of performance for new and exisiting home, UCL.

Barratt, n.d. The Barratt Green House – The First Code for Sustainable Homes Level 6 house built by a major homebuilder.

BBC, 2011. BBC Weather.www.bbc.co.uk/weather. (accessed 08 February 2011)

Bell, M., Wingfield, J., Miles-Shenton, D., Seavers, J., 2010. Low Carbon Housing: Lessons from Elm Tree Mews. Joseph Rowntree Foundation.

Bere Architects, 2012. Larch House.www.bere.co.uk/larch-house. (accessed 12 March 2012)

Berlin, I., 1998. The Proper Study of Mankind: An Anthology of Essays. Pimilico, London.

Berry, W., Lewis-Beck, D., Michael, S. (Eds.), 1986. New Tools for Social Scientists: Advances and Applications in Research Methods. Q-technique and method. Sage Publications, Berverly Hills, London, New Delhi.

Bijker, W.E., 1997. Of Bicycles, Bakelites, and Bulbs – Towards a Theory of Sociothechnical Change. MIT Press, Cambridge.

Bleaunau Gwent County Borough Council, 2012. The Works: Ebbw Vale.

Bradley, D., 2009. Good Practice: Canolfan Hyddgen, Dyfi Valley Pathfinder Project, Machynlleth. Powys County Council, WAG, WLGA, Excellence Wales.

Bradley, J., 2007. Widening Participation in Higher Education: Constructions of "Going to University" by Young People from Former Coalfield Communities.

Brand, R., 2005. Synchronising Science and Technology with Human Behaviour. Earthscan, London.

BRE, Faithful and Gould, 2008. The Cost of BREEAM in Schools. BRE + Faithful and Gould.

Brinkley, M., 2007. Passive-house Thoughts and Reflections. [online]. Housebuildersupdate.www.housebuildersupdate.co.uk. (accessed 02 April 2008)

Brown, S.., 1993. A Primer on Q Methodology. Operant Subjectivity 16, 91–138.

Browne, L., 2012. Passive House Apartment Building is First of its Kind in Berlin. Green Building Community.

BSRIA, UBT, 2009. The Soft Landings Framework – for better briefing, design, handover and building performance in-use. BSRIA.

Butcher, B., 2009a. Green Building Store: Passivhaus Diaries. Passivhaus Diaries.www.greenbuilding store.co.uk. (accessed 12 March 2012).

Butcher, B., 2009b. Passivhaus project reveals flaws in Code. Passivhaus Diaries.www.greenbuilding store.co.uk. (accessed 12 March 2012).
Butcher, B., 2009c. Early Lessons and Preparation. The Passivhaus Diaries Part One. Passivhaus Diaries.www.greenbuilding store.co.uk. (accessed 12 March 2012).
Butcher, B., 2009d. Why we chose Cavity Walls. Passivhaus Diaries.www.greenbuilding store.co.uk. (accessed 18 April 2012).
Bynman, A., 2008. Social Research Methods, 3rd ed. Oxford University Press, Oxford, New York.
Calcutt, J., 2007. The Calcutt Review of Housebuilding Delivery. Department of Communities and Local Government.
CEPHEUS, 1997. CEPHEUS: Cost Efficient Passive Houses as EUorpean Standards (Project Proposal).
CEPHEUS, n.d. CEPHEUS Passivhaeuser.www.cepheus.de. (accessed 12 June 2009).
Cervi, B., 2011. Budget scores zero for homes U-turn. CIBSE Journal Vol 3, 5.
Christensen, M.C., 2003. The Innovators Dilemma. Harper Collins, New York.
Clarke, J., Clarke, R., 1974. The Philosphy and Aims of the Proposed Community, in: Services for an Autonomous Research Community in Wales. Cambridge University Department of Architecture, Cambridge UK.
Clarke, L., 2010. Skills needs and barriers to zero emissions construction, in: Skills Needs and Barriers to Zero Emissions Construction. Presented at the Centre for the Production of the Built Environment (ProBE), University of Westminster.
Clarke, L., Herrmann, G., 2004. The institutionalisation of skill in Britain and Germany: Examples from the construction sector, in: Warhurst, C., Grugulis, I., Keep, E. (Eds.), Skills That Matter,. Palgrave Macmillan, Basingstoke.
Clarke, L., Herrmann, G., 2007. Divergent divisions of construction labour: Britain and Germany, in: Dainty, A., Green, S., Bagilhole, B. (Eds.), People and Culture in Construction. Taylor and Francis, London and New York.
CLG, 2006. Code for Sustainable Homes: A step-change in sustainable home building practice. Department of Communities and Local Government.
CLG, 2007. Building a Greener Future: Towards Zero Carbon Development - Consultation. CLG.
CLG, 2010. Shapps: We're lifting burdens from the backs of builders.www.communities.gov.uk. (accessed 30 April 2012)
CLG, 2012. 2012 consultation on changes to the Building Regulations in England: Section two - Part L (Conservation of fuel and power). DCLG.
Cole, R.., Brown, Z., Mckay, S., 2010. Building Human Agency: A Timely Manifesto. Building Research and Information 38, 339–350.
Dalgarno, S., n.d. The Future of Low Carbon Homes: Learning from Sigma Home Monitoring and Occupancy.
Davies, H., 2012. Greater than the Parts. CIBSE Journal Volume 4, 32–35.
Dawkins, R., 1989. The Selfish Gene. Oxford University Press.
DCLG, 2009. The Code for Sustainable Homes – Case Studies. DCLG.
DCLG, 2010. English Housing Survey Housing Stock Report 2008. Department of Communities and Local Government.
DECC, 2008. Climate Change Act 2008. DECC.
DENA, n.d. German Energy Saving Ordinance (EnEV 2009).www.zukunft-haus.info.(accessed 14 April 2012).
Dewsbery, V., n.d. International Building Regulations.www.international-building.com.(accessed 11 April 2012).
Diamond, J., 2005. Collapse: how societies choose to fail or suceed. Penguin, London.

Douglas, M., Wildavsky, A., 1982. Risk and Culture: An essay on the selection of technological and environmental dangers. University of California Press, Berkley, CA.
Egan, J., 1998. The Report of the Construction Industry Task Force to the Deputy Prime Minister, John Prescott, on scope for improving the quality and efficiency of UK construction. Department of Trade and Industry.
Encraft, Pilkington Energy Efficiency Trust, Warwick District Council, BRE Trust, 2009. Microwind - a catalyst for change in UK energy culture. UK.
FAAG, 2001. Wohnen bei St. Jakob: 19 familienfreundliche Wohnungen im Passivhaus Standard in Frankfurt Bockenheim. FAAG, Frankfurt am Main, Germany.
Feist, W., 1997a. The Passive House in Darmstadt-Kranichstein - Planning, Construction, Results (No. 4), Technical Information PHI. PHI, Darmstadt, Germany.
Feist, W., 1997b. Lueftung im Passivhaus (No. Protokollband Nr. 4). PHI, Darmstadt, Germany.
Feist, W., 1998a. Sparsames Wäschetrocken (No. CEPHEUS-Projektinformation Nr. 4). Passivhaus Institut, Darmstadt.
Feist, W., 1998b. Elektrische Geräte für Passivhäuser und Projektierung des Stromverbrauchs (No. CEPHEUS-Projektinformation Nr. 3). Passivhaus Institut, Darmstadt.
Feist, W., 2006. Wolfgang Feist. 15 jähriges Jubiläum für das Passivhaus Darmstadt – Kranichstein – Der Faktor 10 ist Realität.www.passivhaustagung.de/kran.passivhaus.(accessed 10 May 2009).
Feist, W., Grün, L., Kah, O., Kasche, J., Münzenberg, U., Thumulla, J., Pfluger, R., Schneiders, J., 2003. Protokollband Nr. 23. Arbeitskreis kostengünstige Passivhaüser Phase 111. Einfluss der Lüftungsstrategie auf die Schadstoffkonzentration und ausbreitung im Rau (No. Protokollband Nr. 23). Passivhaus Institut, Darmstadt.
Feist, W., Heidt, F.., Michael, K., Peper, S., Stärz, N., Heidemann, Mandel and Rebholz, 2008. Protokollband Nr. 18. Arbeitskreis Kostengünstige Passivhaüser Phase 11 – Qualitätssicherung beim Bau von Passivhaüsern (No. Protokollband Nr. 18.). Passivhaus Institut, Darmstadt.
Feist, W., Schneiders, J., Dorer, V., Haas, A., 2005. Re-inventing air-heating: Convenient and comfortable within the frame of the Passive House concept. Energy and Buildings 37, 1186–1203.
Flyvberg, B., 2006. Five Misunderstandings About Case-Study Research. Qualitative Inquiry 12, 219–245.
Foxon, T.., Gross, R., Chase, A., Howes, J., Arnall, A., Anderson, D., 2005a. UK innovation systems for new and renewable energy technologies: drivers, barriers and system failures. Energy Policy 2123–2137.
Foxon, T.., Gross, R., Chase, A., Howes, J., Arnall, A., Anderson, D., 2005b. UK innovation systems for new and renewable energy technologies: drivers, barriers and system failures. Energy Policy 2123–2137.
Freeman, C., Soete, L., 1997. The Economics of Industrial Revolution, 3rd ed. Pinter, London.
Gaze, C., 2008. Applying the Code for Sustainable Homes on the BRE Innovation Park: Lessons Learnt about Building Fabric (No. IP9/08 Part 1). BRE.
Gaze, C., Clift, M., 2008. Applying the Code for Sustainble Homes on the BRE Innovation Park: Lessons Learnt about Architecture, Construction and Material Sourcing (No. IP9/08 Part 4). BRE.
Gaze, C., Swainson, M., Hodgson, G., Balson, T., 2008. Applying the Code for Sustainable Homes on the BRE Innovation Park: Lessons Learnt about Energy Sources, Overheating and Ventilation (No. IP9/08 Part 2). BRE.

Geertz, C., 1973. The Interpretation of Cultures, 2000 Edition. ed. Basic Books, New York.
Geraint, E., Barry, J., Robinson, C., 2006. Renewable Energy and Discourses of Objection: Towards Deliberative Policy Making – Summary of main research findings (Academic). Queen's University, Belfast. ESRC (Economic Social Research Council), Belfast.
GHA, 2012. The Good Homes Alliance.www.goodhomes.org.uk. (accessed 15 September 2012)
Gladwell, M., 2001a. The Tipping Point – how little things can make a big difference. Abacus, UK.
Gladwell, M., 2001b. The Tipping Point – how little things can make a big difference. Abacus, UK.
Gladwell, M., 2006. Blink: The Power of Thinking without Thinking. Penguin, London, New York, Toronto.
Green Building Store, 2010. The Green Building Store: Denby Dale Passivhaus.www.greenbuildingstore.co.uk. (accessed 01 Jan 2011).
Guy, S., Shove, E., 2000. A Sociology of Energy, Buildings and the Environment: Constructing Knowledge, Designing Practice. Routledge, London.
Haig, B., 2005. An Abductive Theory of Scientific Method. An AbductiveTheory of Scientific Method 10, 371–388.
Hames, D., 2010. Chairman's Address, in: Skills for the Green Economy. Presented at the Westminster Forum Projects, Seligman Theatre - Royal College of Physicians.
Harris, J., 1998. The nurture assumption: Why children turn out the way they do. Free Press.
Herbert, G., 1984. The Dream of the Factory-Made House – Walter Gropius and Konrad Wachsmann. The MIT Press, Cambridge, Massachusetts, London.
Hestnes, A.., Hastings, S.., Saxhof, B., 1996. Solar Energy Houses: Strategies, Technologies, Examples. James and James Science Publishers, London.
HHP, 2002. Sustainable Housing Schemes in the UK – A guide with details of access. Hockerton Housing Project.
Hill, F., Lynch, H., Levermore, G., 2011. Consumer impacts on dividends from solar water heating. Energy Efficiency 4.
Hodgson, G., 2008. Passivhaus in the UK: Challenges of the Emerging Market. Presented at the 12th International Conference on Passive Houses, PHI, Nuremberg.
Hoogma, R., Kemp, R., Shot, J., Truffer, B., 2002. Experimenting for Sustainable Transport: The Approach of Strategic Niche Management. Spon Press, London and New York.
Hulme, M., 2009. Why we Disagree about Climate Change – understanding controversy, inaction and opportunity. Cambridge University Press., Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Dehli.
IEA, n.d. The Zero-Heating House, Peterculture, Aberdeen, Scotland.
IEE, 2006. Passive House Solutions.
IgPassivhaus, 2013. Passivhaus Vorarlberg.www.igpassivhaus.at/vorarlberg. (accessed 20 May 2013).
Kelling, G., L., Coles, C., M., 1996. Fixing Broken Windows. Touchtone, New York.
Keul, A.G., 2010a. Energy monitoring and analysis of user sastisfaction in existing Passive House housing estates in Austria. Presented at the 14th International Passive House Conference 2010, PHI, Dresden.
Keul, A.G., 2010b. Akzeptanz des Passivhauses im Massenwohnbau, Evaluation (POE) acht oestereichischer Siedlung im Altbauvergleich. Umweltpsychologie 14.
Killip, G., 2008. Transforming the UK's Existing Housing Stock. A Report for the Federation of Master Builders. Environmental Change Institute, Oxford University, Oxford, UK.

KlimaSolarHaus, 2009. KlimaSolarHaus Berlin.www.klimasolarhaus-berlin.de. (accessed 04 February 2011).
Kluckhohn, C., 1949. Mirror for Man: The Relation of Anthropology to Modern Life. Whittlesey House, USA.
Krueger, R.A., Casey, M.A., 2009. Focus Groups - A Practical Guide for Applied Research, 4th Edition. ed. Sage Publications, Los Angeles, London, New Dehli, Sinagpore, Washington DC.
Laible, J., 2010a. Hoher Komfort, sehr grosze Akzeptanz, keine Probleme - Interview with Franz Junker. Passivhaus Kompendium 2010 1.
Laible, J., 2010b. Wir stehen erst am Anfang! Passivhaus Kompendium 2010 19–19.
Latour, B., 1992. Where are the missing masses? The Sociology of a few Mundane Artifacts, in: Bijker, W.., Law, J. (Eds.), Shaping Technology/Building Society: Studies in Sociotechnical Change. MIT Press, Cambridge MA, pp. 225–264.
Law, J., 1987. Technology and Heterogeneous Engineering: The Case of Portuguese Expansion, in: The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. MIT Press, Cambridge MA.
Lazaraus, N., Bioregional Development Group, 2004. Beddington Zero (Fossil) Energy Development – Toolkit for Carbon Neutral Developments – Part 11. DTI.
Leaman, A.,Stephenson, F.,2010 - Editorial - Evaluating Housing Performance in Relation to Human Behaviour: New Challenges. Building Research and Information 38, pp. 437-441

Lowe, R., 2000. Ventilation Strategy, Energy Use and CO2 Emissions in Dwellings - A Theoretical Approach. Building Services Engineering Research and Technology 21, pp. 179–185.

Lundvalle, B., 1992. National Systems of Innovation:Towards a Theory of Innovation and Interactive Learning. Pinter, London.
Lynch, H., 2010. The Evolution of Passive Houses in the UK. Presented at the 14th Annual Passive House Conference 28-29 May 2010, PHI, Dresden, pp. 509–510.
Lynch, H., 2011a. The Works: Passivhaus Dwellings at Ebbw Vale.Film. Directed by H. Lynch .
Lynch, H., 2011b. Living in a Passivhaus.Film. Directed by H.Lynch.
Mlkakar, J., Strancar, J., 2011. Overheating in Residential Passive House: Solution Strategies revealed and confirmed through data analysis and simulations. Energy and Buildings.
Mokyr, J., 2002. Technologies and Institutions, in: Steil, B., Victor, D., Nelso, R. (Eds.), Technological Innovation and Economic Performance. Princeton University Press, Princeton, NJ.
Moore, G.A., 2007. Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers, Second. ed. Capstone.
Morbitzer, C., 2008. Low Energy and Sustainable Housing in the UK and Germany. Open House International 33.
Morgan, D.L., 1997. Focus Groups as Qualitative Research - Qualitative Research Methods Series 16, Second edition. ed. Sage Publications, Thousand Oaks, London, New Dehli.
Olcayto, R., 2007. Eco-homes Fail Final Build Test. Building Design.
Passivhaus Trust, 2011. Passivhaus and Carbon Compliance. Passivhaus Trust, n.d. What is Passivhaus. The Passivhaus Trust.
Passivhausprojekte, 2012. Gebaute Passivhaus Projeket. www.passivhaus.org.uk. (accessed 18 May 2012).

PCC, 2010. Canolfan Hyddgen - Bro Ddfyi's Post -16 Training and Education Centre and Customer Services Point - Annual Report 2010. Powys County Council.
Pearson, A., 2011. Passive Performer. CIBSE Journal 37, 34–39.
Peder, A., 2010. From Bauhaus to Ecohouse – A History of Ecological Design. Louisiana State University Press, US.
Peper, S., Feist, W., Pfluger, R., 2004. Ein nordorientiertes Passivhau. PHI, Darmstadt, Germany.
Pfaffenberger, B., 1992. Technological Dramas. Science, Technology and Human Values 17, 282–312.
Pfluger, R., Feist, W., 2008. Nutzerhandbuch für den Geshoβwohnungbau in Passivhaus-standard. Teil A: Nutzerhandbuch. Aktenzeichen: B 15-80 01 98-15. Passivhaus Institut, Darmstadt.
PHI, 2009. Active fo More Comfort: The Passive House.
PHI, 2012a. Gebaute Passivhaeuser.www.passivhausprojekte.de. (accessed 14 May 2012).
PHI, 2012b. What will all this cost. Passipedia.www.passipedia.org. (accessed 20 May 2012)
PHI, iPHA, n.d. What is a Passivhaus. Passipedia. www.passipedia.org. (accessed 20 May 2012)
RAE, 2010. Engineering a Low Carbon Built Environment: The Discipline of Building Engineering Physics. The Royal Academy of Engineering.
Reason, L., 2012. Carbonlite Funding.Email Liz Reason toHenrietta Lynch. 16 April 2012.
Roberts-Hughes, R., 2011. The Case for Space: The Size of England's New Homes. RIBA, London.
Rogers, E.M., 2003. Diffusion of Innovations, 4th ed. Free Press, New York.
SBSA, 2007. A Low Carbon Building Standards Strategy for Scotland – Report of a Panel Appointed by Scottish Ministers, chaired by Lynne Sullivan. Scottish Building Standards Agency.
Seale, C. (Ed.), 2004. Researching Society and Culture. Sage, Los Angeles, London, New Dehli, Sinagpore, Washington DC.
Shurcliff, W.A., 1981. Super Insulated Houses and Double Envelope Houses. Brick House Publishing Co Inc, Massachusetts.
Skaates, A.M., Tikkanen, H., Alajoutsijärvi, K., 2002. Social and cultural capital in project marketing service firms: Danish architectural firms on the German market. Scandinavian Journal of Management 18, 589–609.
Smith, A., 2007. Translating Sustainabilities between Green Niches and Socio-Technical Regimes. Technology Analysis and Strategic Management 19, 427–450.
Speirs, J., Pearson, P., Foxon, T.., 2008a. Adapting Innovation Systems Indicators to assess Eco-Innovation - DIME Conference Proceedings. DIME, Bordeaux.
Speirs, J., Pearson, P., Foxon, T.., 2008b. Adapting Innovation Systems Indicators to assess Eco-Innovation - DIME Conference Proceedings. DIME, Bordeaux.
Stafford, A., Gorse, C., Shao, L., 2011. The Retrofit Challenge: Delivering low Carbon Buildings (No. 004). Centre for low Carbon Futures 2011.
Stephenson, W., 1935. Correlating Persons Instead of Tests. Character and Personality 4, 17–24.
Stephenson, W., 1936. The Foundations of Psychometry: Four Factor Systems. Psychometrika 1, 159–209.
Stephenson, W., 1953. The Study of Behaviour: Q-Technique and its Methodology. University of Chicago Press, Chicago.
Stevenson, F., Rijal, H., 2008. The Sigma House: Towards an Authentic Evaluation of a Prototype Building. Presented at the PLEA 2008 - 25th Conference on Passive and Low Energy Architecture, Dublin.

Todd, R., 1979. Energy and Buildings at the Centre for Alternative Technology. Technical Information Report No. 1 (Technical Information Report). CAT, , Artists Valley Press.
Toynbee, A.., 1960. A Study of History: Abridgement of Vols I-X in one volume. Oxford University Press, Oxford.
Trebesberg, 2009. Nachhaltigkeitsmonitoring ausgewaehlter Passivhaeuser in Wien (Projekt NaMAP) Zusammenfassung, Wien Projektbericht.
Trinick, J., n.d. Passivhaus vs. the UK Approach - A non-technical comparison of the different principles. WARM.
Tunstall, G., Tunstall, K., 2010. Passivhaus Diaries: Life at Denby Dale. Passivhaus Diaries.
Twinn, C., 2008. MVHR and Energy at BRE Innovation Park. Email Chris Twinn to Henrietta Lynch. 10 December 2008.
Vale, B., Vale, R., 1975. The Autonomous House: Designing and Planning for Self-Sufficiency. Thames and Hudson, London.
Van der Pluijm, W.M.P.J., 2010. The Robustness and Effectiveness of Mechanical Ventilation in Airtight Dwellings - A Study to the Residential Application of Mechanical Ventilation with Heat Recovery in the Netherlands (Masters Thesis). Eindhoven University of Technology, Eindhoven.
Van Hal, A., 2000. Beyond the Demonstration Project - The Diffusion of Environmental Innovations in Housing (Masters Thesis). Technische Universiteit Delft, Delft.
Von Weizaecker, E., Lovins, A.., Lovins,, H.L., 1998. Factor Four: Doubling Wealth, Halving Resource Use. Earthscan, London.
Warm, P., Woolley, T., 1999. Ventilation. Green Building Digest - School of Architecture Queen's University, Belfast 9.
Watts, D.., 2004. Six Degrees – The Science of a Connected Age. Vintage Books, London.
Watts, S., Stenner, P., 2005. Doing Q methodology: theory, method and interpretation. Qualitative Research in Psychology 2, 67–91.
Watts, S., Stenner, P., 2012. Doing Q Methodological Research - Theory, Method and Interpretation. Sage, Los Angeles, London, New Dehli, Sinagpore, Washington DC.
Williamson, J., 2009a. First Certified non-domestic Passivhaus in UK. Green Building Magazine 19, 12–15.
Williamson, J., 2009b. DVPF Canolfan Hyddgen: Passivhaus Offices.
Williamson, J., 2011a. Canolfan Hyddgen (The Stag Centre) Machynlleth, Wales. BRE Trust.
Williamson, J., 2011b. Canolfan Hyddgen - New Build Project of the Year: Synopsis of the Project and its Performance and Low Carbon Objectives. JPW Associates, Machynlleth.
Williamson, J., 2012. Phone call with John Williamson 18.04.12.
Wingfield, J., Miles-Shenton, D., South, T., Lowe, R., 2007. Evaluating the impact of an enhanced energy performance standard on load-bearing masonry domestic construction. Lessons from Stamford Brook – understanding the Gap between Designed and Real Performance (No. Partners in Innovation Project: CI 39/3/663. Report Number 8 – Final Report). Leeds Metropolitan University.
Woodfoode, J., 1970. The Story of the Bicycle. Routledge and Kegan Paul, London.
ZCH, 2011a. Carbon Compliance – setting an appropriate limit for zero carbon new homes – findings and recommendations. Zero Carbon Hub.
ZCH, 2011b. Allowable solutions for tomorrow's new homes - towards a workable framework. Zero Carbon Hub, Milton Keynes.

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Passivhaus in the UK: The Challenges of an Emerging Market

A Case Study of Innovation using Mixed Method Research

Henrietta Lynch

Appendices

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Transcription – H Lynch Passivhaus Pilot Focus Group,

1-19 Torrington Place, UCL – 29th May 2009

Me – First of all perhaps we could start by you introducing yourselves and saying a little bit about why you are here – apart from the fact that I asked you.

I'm (**DS**) from an organisation called 00, I'm an architect and we have designed and are designing Passivhauses.

I'm (**PS**) I work at Inbuilt consulting – we have been looking at Passivhaus suppose for the last year and a half since I joined Inbuilt – we are advising on a number of projects with clients.

I'm (**DN**) a retired entrepreneur with lots of interests one of which is to build my own Passivhaus.

I'm (**SD**) from architects Youmeheshe, we're trying to look at mass produced Passivhaus.

I'm (**JB**) from Bere architects we're also doing Passivhaus.

I'm (**SS**) also from Inbuilt, I working with Paul on some Passivhaus projects

I'm (**SV**) from Venner Lucas architects, we're also doing Passivhaus – new build but also refurbishment as well.

I'm (**SJ**) from BDP (Building Design Partnership) – sustainability consultant – looking at efficiencies in buildings similar to Passivhaus but not Passivhaus itself – I'm interested in all that area.

I am (**JG**) from Hoare Lea – I'm an engineer and I'm in the sustainability group, personally I'm not involved in any Passivhaus projects but we are giving advice on one or two 'Passive' designs.

I am (**AP**) from the Centre for Alternative Technology – I'm a senior lecturer there, we're looking at Passivhaus from an academic point of view, but we do have the first Passivhaus office in Machynlleth which I took our architecture students round last month.

I'm (**CG**) from the University of Westminster, and I'm a building services engineer and I'm interested in energy and it just makes sense to me.

I am (**CGu**) from the London Borough of Camden, I'm in our planning policy team – I've been asked by one of councillors who calls himself the eco-champion to attend – so I've just come along to learn and see and see what I can bring back to the office.

Me – to get things moving can I just remind you of the question.... What are the constraints to uptake of Passivhaus design in the UK?

SS – can I ask if you are looking at purely domestic or commercial?

Me – both

SS – there are different variables – just saying that you have drivers on the domestic side of things such as the Code for Sustainable Homes that you don't have so much with commercial, yet and with commercial I think you have a lot of problems with things like who actually builds the building and who actually operates it – In a nutshell, there's much more to it than that...

JG – that's generally lack of incentives – also in planning, I mean – most authorities now have policies on renewables that they apply – the rule on so many percent but if you propose a very low energy design it is not necessarily going to help you at planning so why do it? –

SJ – and I think that people are stuck in the ways that they have always done things – I think it is really difficult to get out of that rut – if there is an incentive, or there is a big big push – it is also education, a lot of people don't know anything about it or have heard of Passivhaus –

in industry, talking to architects, they don't know about it – I guess educating people about it – telling everyone why it is important and then getting through to Government bodies to push to push that along.

DN – a key point about the CSH is that it is far too complex and had the Government actually said there is a model that works in Germany and Austria and elsewhere and it is very very simple, there are only four things that we all know about air-tightness, insulation, fenestration and thermal bridging, they could have said, that's what's happening, the spec exists let's make that the Government target, but typical British complexity – lack of imagination – we are good at doing the pop stuff but we are sure not good at in my opinion at doing engineering as we used to be years ago.

CGu – but we are saying about the other things, biodiversity and water savings –

DN – Can I challenge you about the water saving bit – it is not rocket science, we have for example water harvesting – all the papers that I have read – by the way I'm probably the only non-professional here – I'm ah, it just isn't worth the money and it would be much better to concentrate on something that is achievable rather than do too much – I think it is a great fault we make things too complex we have got too many boxes to fill when actually the notion of Passivhaus is relatively easy to do.

SJ – also getting the base build right – just getting the fundamentals of the construction right and then building up on all these other things – sustainability etc. and putting the green roofs on – just getting the construction right in the first place.

DS – I wonder whether there is something more deep rooted about our cultural relationship to the home – in especially the last two decades – homes have been seen as an almost financial instrument – there is almost this trade up mentality – it is kind of equity release and all that, they are seen as a kind of commodity – the mass house-builders have built it as a commodity, we are saying, who builds buildings and who has the liability of them? – it's been built to minimum standards to maximise the profits very short term – the owners have bought

them and with a cosmetic make-over they sell them on – we haven't had a deep rooted relationship – this is a home, it's in our interest – there has been some research – what is the payback period for an incentive for a British householder to invest in it when we are talking about loft insulation and wall insulation – it's about 2 and a half years, if someone hasn't re-couped their money in two and a half years, they won't do it because they think they are going to move on and sell on – so I think we have this relationship with homes in the vast majority where people haven't invested like in Germany where homes, which is actually theirs for a long period of time and might even be passed on to their children – only people, talking about RSLs – people who are sort of end users or they have a lot of long term liability does it make sense to worry about that such long term things such as savings and conservation those kind of things – so I think it's not just not the mechanics of the incentives as to why do it - it's quite cultural I think, about our whole relationship to buildings.

PS – I think linked to that payback thing, you wouldn't ask for a payback from kitchen a non-functional thing – I think we are actually terrible at selling the non-energy non-environmental benefits of Passivhaus – this is something that is done more in Austria and Germany – and I think we don't link it enough to fuel costs – we are talking carbon – it wasn't developed in Germany to stop carbon emissions or to tackle climate change – as far as I know it was developed as part of a fuel security issue – there are a lot more drivers that we could come at it from for example – health and comfort in buildings, international energy security, we might by actually making those sorts of arguments we are just making the carbon argument – and up against the CSH it really is six of one and half a dozen of the other, because both can deliver very very low carbon buildings – the one does it with energy reduction at the heart the one does it with carbon reduction at the heart – so I think that needs to be discussed a bit more

DN – but it's not even carbon reduction because if you take the CSH you can effectively not produce a low energy home but it can be offset with renewables – again one of the things

that would be hugely beneficial would be if the whole of the offset thing was taken away and the whole emphasis was on low energy. The problem with the offset is – you put in your PV panels with a 50 year payback and um solar thermal maybe – yeah it works – yeah it certainly doesn't work on PV and then look at heat pumps and I think there is a huge amount of waffle there – when you actually look at the real efficiencies – they do not publish a co-efficient of performance at effectively the different input temperatures and the output temperatures – so heat pumps effectively are again something that people are being sold but actually aren't of good value and to cut CO_2 –

JG – I'm sorry I disagree – I think offset has its place when you are talking about specific locations for designs – when you go again in an office for a few stories and you design something

DS – there are very definite principles – if you concentrate on energy conservation to start with, and that's why Passivhaus is a very good concept, it's not actually looking at achieving some notion of low energy through different means – whatever you do even if you did chose to go to PV at some point – doing very good fabric construction is worthwhile

JG – I think for example with BREEAM and the CSH it goes a bit further in that we all know that in an office, we all know that space heating is not going to be the main problem its cooling – if not so Passivhaus is still not ...if it only addresses space heating it is still not ..

DS – but to do a 'Passiv' office building, it reduces the requirement of your cooling energy

PS – I do think that is an important point if it is just an energy issue, from everybody I have spoken to they have had a different experience in Germany – although they think our CSH is ridiculous, they also think it is quite good that it addresses things that they are not addressing at the moment for example water efficiency and material issues – so I have added those to the discussion

JB – but they do those things automatically – I mean, anyone who does a Passivhaus building without saying would look at the water and location and so on, probably far more effectively than those CSH buildings from the start – they are much more aware of ecological issues – we all use foam based insulation and that's just hardly done in a Passivhaus building - so I think it is a sort of mentality

PS – is it say more educated people who build Passivhauses?

JB – yes I think that is partly the case, but I think there are plenty of people who frankly understand who are frankly too greedy to do otherwise – we've heard the section about payback, that and there are also commercial interests in sustaining the CSH – whilst the zero carbon consultation said we should be moving towards a Passivhaus system in SAP, they are not adopting Passivhaus – why? Because there is a lot of commercial interest – the BRE I understand have been paid £500,000 at the start of this year to start bringing SAP up to Passivhaus – you can get Passivhaus for nothing (PHPP) – so there is all sorts of interests – there is someone who I understand in good authority, who in Ed Miliband's department who will not have anything to do with anything that is not SAP or the BRE and basically stops it. Ed Miliband has told me it is very difficult to get really good information – and be sure if that information is good information and not filtered information – so there are all sorts of problems – and some of that means going direct to the ministers

PS – that's an interesting point in terms of leadership on Passivhaus – who owns it? Now my understanding of Passivhaus is that it is not particularly commercial – if anything it runs more like a social enterprise or a research arm – there is a fear that it is going to be in the hands of a commercial organisation unless people can make the effort for it not to be – in doing that inevitably the tariffs to be involved are going to be higher – it's all about the freedom of information of Passivhaus it's not going to be there and I think that Passivhaus in Germany is developed as an open-source movement – it's like it's not like Microsoft it's kind of like

Linux – and we need to do the same with Passivhaus in the UK or not going to get anywhere – I think a lot of that is linked to commercial incentives too –

DN – can I comment on that – is this to Chatham House Rules – and is it confidential?

Me – yes

DN – but what I can tell you is that there are things going on behind the scenes which will come out in the not too distant future, which I believe will have a not for profit and a Linux model in the UK – and I'm involved in it – and I can't say any more than that but I think it is...

CG – I am sorry – I am lost –

DN – the point is the Passivhaus Institut in Germany is effectively run by Dr Feist – if you actually look at the notepaper – basically it puts him as the Passivhaus Institut but he doesn't go and licence things out – he effectively makes it the equivalent of open-source software – PHPP you buy for 120 euros or whatever it is but, you get the entire spread sheet and it isn't that protected so it is done on the basis of honour and that is clearly a fantastic model it is very altruistic – but he is quite a difficult guy to work with – but the same I believe will happen in the UK in the next half year – and that will mean that the know-how will effectively become something that is very low cost to acquire and easy to take from conceptual into actual practical applications of it.

JB – the problem is that if even if it is very easy for people to get hold of they are not incentivised by the building control officers say to use Passivhaus or PHPP and most people wouldn't use it and people will only do what they need to do, including architects – to get through the code so, I threw away my SAP software a long time ago! – and we only use PHPP – and we have been persuading building control officers to accept that – you know it is quite difficult if you point out it is much better – whereas SAP is totally useless – it has been the case so far that they will accept it – most people can't be bothered to do that –

AP – I think if more models come on line like the office building in Machynlleth that was driven by the local authority – because they were being driven by predictive energy pricing – so they were compelled to reduce their energy demand in their buildings across the board so that is a driver in that respect – it is like anything in this environmental field, there is no one clear answer or clear obstacle, I guess the drivers will be if more buildings come on line and the software is available, and the experience is available, all the documents have been translated that need to be translated – as they say they are all originally in German –

JB – just to say what is possibly is around the corner – at the moment we are going to have to deal with PHPP and say that it is so much better and so on and they will ...and I think that with the current trajectory on SAP – they'll have a fairly ropey copy of Passivhaus (PHPP) – and then it would be much more difficult to argue that ... and we are pushed into using something rather ropey..

DS – PHPP does demand a whole lot of trust because it is incredibly opaque – you put in your figures and you believe what it gives you – it is very difficult for anybody to actually analysis it because it is the world's most complicated excel – and the formulas – tracing some of those hidden cells and things is nigh on impossible – the equations in it are incredibly opaque – we have done the same thing with the local authority we got them to look at it and did a parallel SAP with them, which gives you different answers – both comply but – but the moment I am not sure if everyone can formally say if PHPP is an approved method –

Me – can I just interject here and ask of all of you, who uses or who has used PHPP?

Answer – 6

DS – I think a comment is – it is currently not a transparent thing – although it is freeware – but to an outsider you look at these multi-pages in excel it is not a self-explanatory thing and it just give you an answer – how you get that answer is...

PS – on CSH and SAP it is actually quite likely that it will become harder – to do Passivhaus in the UK because someone will claim , you say that SAP will become just like PHPP and why bother with this other software at all? Do we mind as long as the output is a very very low energy building?

JB – some people have been working developing PHPP for 15 years – if there are any questions there is someone very authoritative that can give you an answer in the UK like Peter Warm...

DS – I am an advocate but there are massive short-comings – I think there are some really fundamental problems –

JB – Like?

DS – over-shading – the formula for the calculation of that is incredibly crude –

JB – it involves taking every single window of a building and saying – how high on the horizon is it and how far away it is

DS – if an object is not due in front of it, it is discounted and if it is in front of it is infinitely wide – that's the basis of calculation in PHPP – which, I'm an advocate for PHPP but I think it does a great job, but it's going to get a lot of flak – if we try and defend it and it's got such kind of anomalies as that in it – there's a list of about half a dozen, which are pretty serious, if you are not aware of them.

JB – I think that ... that it is proven to be good enough for the few who want to do – we have got something – it is more accurate than anything apart from something like dynamic modelling

CG – are we getting off track here because we are discussing the limitations of PHPP and SAP or NHER or BREDEM or what have you – SAP is based on BREDEM and there's 15 years worth of work gone into BREDEM as well – so I think that if you have said that the

output of SAP if you looked at – if we are going to talk techy – and we look at the heat loss parameter then you get sense and the heat loss parameter is based on how much heat per meter squared over floor area you require per annum – and if you go for 0.8 that's the equivalent of Passivhaus so you know it may not be exactly there, it might be slightly above in some cases it might be slightly below but in terms of where we want to go that's where we want to get to – we want people to be aiming at getting the equivalent – something very similar to Passivhaus – how they do it what software they use – this doesn't really make a lot of difference. You have got to be able to get all of your developers, your planners, your building control, your builders all to see that this is where you are going – that's I think the key issue – not with software

DN – I agree I think the most important part - it comes back to our builders and skills sets and I think there is a huge need for training and I also think there is a huge need for a media campaign so that people can begin to understand what Passivhaus is all about – it is a brand, an uncomfortable brand in a way - it's German it has the 'haus' which obviously means building and it doesn't mean house which doesn't help but I think that there is a message which could be something along the lines of low bills, high comfort and sustainability – that is a lesson that could be developed – PHPP understand – I'll doubt they will understand

DS – I have dragged this conversation back to choice or compulsion – are we going to legislate so that people have to do it or are we going to engage people and say think – I think that is why there is a complete different culture – in mainland European countries because there is a different society and actually they are doing it not because they are making £500 energy savings a year, they are doing it for broader social value and understanding and environmental sensibilities and either we have got to get our population to aspire to do these things and therefore say I want to build a Passivhaus or we are saying we have to legislate and somebody is going to tell them – you will have to do it

JB – we need to legislate because there isn't enough time

SS – it is still not mainstream in Germany though – at the conference that we went to you have still got to realise that its only in the 1000s – ok in Vienna it's a quarter of new buildings that are Passivhaus standard but I think there is this fallacy that every German is desperate to own a Passivhaus – if you look at the AGB holdings in Frankfurt who are the state of Frankfurt's main provider of social housing - they have blocks of flats that they sell – they are all Passivhaus but the reckon that only 5-10% of people who buy those flats actually want a Passivhaus flat it just happens that is a feature on the back of everything else e.g. all the variables like we have in the UK – the location has to be right, schools all that kind of stuff and then way down the list and by the way you will only pay 8 Euros a month to heat the thing – oh well then maybe I'll move in so I think to say that people in the UK are so far behind and they are so enlightened over there in Germany and Austria is a little bit exaggerated I think in general western societies do not think of energy as being a finite thing that they have to worry about – energy is cheap, they are lazy they will switch a light switch and not think about it – I think it is a malaise on all western society and I think there are variables that mean that we are maybe slower on uptake for these few 1000 compared with what they have been building in Germany and Austria but they are not doing hell for leather over there either

SJ – Isn't a difference that their building regs are better so that getting to Passivhaus is not so much of an ordeal –

SS – we are catching up too – you look at 2010 we are improving by 25% – I think if we do get to zero carbon by 2016 there won't be much in it – and if I think you think of the psychology of people who are actually going to purchase these buildings I don't think there is a huge difference and certainly in the commercial sector I don't think there is a difference – I think multi-national companies will build their headquarters or whatever and office space that they want – they don't care yet about the energy

AP – I don't think we should flagellate ourselves for not being good enough and that up Passivhaus without not turning our back on the existing stock – you have to come back to that at some point all the existing buildings

JB – you can renovate existing to Passivhaus

AP – yeah you can but we have to address that our emphasis would be better engaged in tackling some of those issues rather than people concentrating on I want to build a Passivhaus or a one off new build – and learn to retrofit and perhaps we can't always get to Passivhaus standard for every existing building and we have to go for CSH 4

SV – I think that we need a much greater awareness of about what buildings need to be – I think that will encourage the industry to gear up both in terms of skills and product and price because it is absolutely true that the existing housing stock must be by far the largest element and we would be much better off carbon wise if we were focusing on that – but people need to be informed about what they need to do, but if you are um with existing homes for example – just take one aspect, external wall insulation, if you go as an individual home owner and get a price for externally insulating your house, it is ridiculously high, it is because the industry is set up to do large local authority schemes – and they only want to do the whole street, so there needs to be that focus and I think, there needs to be a much greater emphasis on what needs to be done to create a low energy building, cos a lot of people still don't know – they think oh well possibly double glazing first, or secondary glazing – you know

AP – If they can afford it they think heat pumps

SV – well exactly, that's the other thing they want to put solar thermal panels on before they have draft stripped the front door – so but it's all terribly un-sexy, but it needs to be sexed up to a certain extent – David is shaking his head but, experience...

DS – in Bristol... that is exactly what they said, they refurbished a house in Bristol they did everything, yet with insulation and draft proofing, no-one wanted that they all wanted the little wind turbine on the roof, and the guy said he spent every day trying to talk people out of that - because put the draft excluder on first

SV – it could be so simple, because all you'd have to do (not all) is that the Government to provide a council tax rebate or something else you link in to building control

DS – I don't think that would make it sexy just rather beaurocratic

SV – no but financially advantageous – you know what I mean – it could be done and yet it would save masses and just going back one I do sometimes worry about the combination of Passivhaus and zero carbon because I actually think as a strategy for our nation it would be much more advantageous if we went for a lower level across the board...

JB – a lower level of what?

SV – achievement, I accept that we could go for Passivhaus rather than zero carbon –

DS – Zero carbon is a political slogan

SV – exactly

SD – it's counter productive

JB – It's that zero carbon, it's quite unrealistic

SV – yes that's what I meant – my fear is that it is actually unachievable,

SD – the Passivhaus

SV – no no that the zero carbon is – cos it's going to be quite difficult to get round to actually achieving it, but if we had a standard that was achievable, you would get more compliance

JB – can I just go back to the point about the external insulation – that for existing buildings which are going to be largely inhabited is a 'no brainer' – it has to happen – external insulation has to happen in order to make the biggest significant, the most significant of any refurb in cutting energy costs - so external insulation on a house by house basis to achieve so many millions we have to do over 50 years - to do it on an individual scale is just idiotic – it has to be done on a street scale, it's the Government understanding the scale of what needs to be done and that has to be done and get on and legislate – and that also means kicking the planners into shape because they cannot sit there and accept that buildings external insulation is unsightly – they have to start accepting that we either have no planet and nice pretty buildings or we have a saved planet and insulated buildings – but we need to make sure that the external insulation is also pretty – and then so that –

CG – can I just say – how do you get individual ownership right – how d'you get individuals who own their house to comply with – right if we are going to do the whole street who runs that? How are they going to politically get that?

JB – grants grants

CG – How do you get the whole street?

JB – How do you get in Germany, how do you get roof tops covered in photovoltaics? Whereas we have got virtually nothing here –

CG – but you if you need to in order to do a whole street

JB – help by using banks

CG – but in order to do a whole street you need all the individual owners in that street to agree to do that, don't you, otherwise you are doing one off houses or every third one right?

So how do you legislate to organise that – that is a very serious question that I think that we should look at –

SD – If you start with the social housing, then we don't have the ownership issue – a few millions of those – and then with council tax, if you give somebody the choice to pay an extra 1000 pounds a year on council tax or not they might be quite compliant – I don't think we are ever going to be able to enforce it but you have got to make incentive so that people sign up to it

JB – you'd be a mug if don't do it because you have lost the opportunity – if you do it now you are going to get it effectively for free – because whether it's the energy supplier that's paid for it and it just becomes a small charge on the building or whether it's the Government or that does a loan on the full charge of the building that gets passed on to the owner that gets paid back in 20 years – If you don't do it now, you miss that opportunity – and you'd be a mug if you missed it and yes it would be a little bit cheaper if 10 out of 10 houses in the street did it but if 8 out of 10 did it there would still be a saving and gradually I'm quite confident that more and more people would see the benefits and would join in and they would be looking forward for their street to be done

SS – I don't know why we can't legislate, I think of all the things that we have done, we have gone to a war that nobody wanted to do, we have had so many civil liberties stripped away with this Government, what is insulation compared to all this? –

SV – I mean I agree

SS – you can't protest anymore – I mean they will just put it in so that they don't debate it in the commons and rubber stamp it – there it's the law – I mean this is a war climate change, it's not a party! – If we are serious we have got to just bloody well do it – why do we always just have to get everyone to agree?

AP – I think there is a model for that kind of infectious DIY anyway – we have seen it with crazy paving and stone cladding – UPVC –

JB – that's um... the Merton rule idea is that creates in the end after a short while in the end makes the person who does not have a solar panel on the roof feel out of place so you build up an exponential growth of uptake and I think that that is easily done with the potential for triple glazing to have the same

SJ – that's probably the problem because the insulation and these things that we need to do aren't visible you don't see them

JB – well you do the external insulation

SJ – but people don't necessarily

DS – just in thinking double glazing - in some listed building and people buying a house then you should get the surveyor to say that you are taking off money because it hasn't got double glazing – it has become the accepted standard – why can't we push that bar higher and say well if it hasn't been insulated well this house is sub-standard

AP – that's where I think there will be a problem because if someone came along to a home owner and said we are going to make your house a Passivhaus, we are going to double our glazing salesmen, and say it's going to cost you this but save you this much

DS – they will say it is going to be secure

AP – they will say all these other things as well

PS – if we keep banging on about the energy no-one will be interested – that's it it's a small part of the bill and the overall costs

AP – If you are banging on about the energy related to carbon –

DS – I don't know if the money will either – if people can make £10,000 on appreciating property prices – the fact that they spend £700 more on their fuel bills doesn't matter to them they will re-fit their bathroom before they insulate their house –

PS - the example I have of a client coming asking for a Passivhaus who has got Raynard's syndrome which means that they get very very cold and their limbs suffer – so one of the things that I talk to the client about is often about comfort and say that in the houses you can walk around barefoot and you won't get cold – you can get the children to kiss the glass – talk about those sorts of things and believe it or not – the client kind of peps up a little bit they don't care about the energy, it doesn't matter so I think we need to have lots of arguments going on rather than just one – at the moment it's just carbon – we need touch all the different sides if it is something we want to do and I don't know if anyone has had that experience –

SV – one thing that I have found though is talking about Passivhaus there are a lot of people in the UK who get very worried about this perceived thing of not being able to open the windows – and this whole ventilation thing and its potentially quite terrifying – for the generations and people who have grown up in draughty buildings – so I think that is a kind of big mental barrier – because they have just no experience of what that would be like –

JB – but you can open the windows

SV – yes I know that but, it is a really big problem – but I think the only way that that could be got round is to actually have some structure somewhere that people can actually go and see and actually experience – and just be there

DS – but if an architect has designed it then it will look like something alien and it won't serve your purpose – you need a really mundane house –

SV – a re-furbished house –

SD ...someone's interesting icon and we design it in all glass?

SV – you just need a brief – or just like a terraced house that would then do it – because the whole notion about mechanical ventilation with heat recovery is quite terrifying – for people used to living in a leaky house

SS – my idea is that we have another ghastly – one of these reality TV shows where we have some dreadful B and C list celebrities living in a Passivhaus

DN – that's a good idea

SS – I've been banging on about this for ages

DS – but there wouldn't be any difference

SS – but that would prove it

SD – the only issue that we are coming across is the fact of cost and how much is it to build a house and at the moment we are looking at houses which we are having to build for £1100 per square metre – they want Passivhaus for £1100 per square metre – at the moment we can get it for £1350 per square metre which is fantastic - `compared to other ones which are £2000 per square metre – and they still won't bite – so it is also long term decisions – how a house is going to be – how you can actually market that and how you can pass it on –

DS – It has also got to work in a model that you can sell on – I think that we have got from looking at how we are going to get people to aspire to it to moving on to blunt fact is we have got to legislate for it and would this discussion be different if we had said that tomorrow the Government had legislated that everything would be a Passivhaus, now what are the barriers? Because we have been talking so far all about, well how are we going to get to that point well if it were legislated then where's the obstacle?

SD – now everybody's waiting for 2016 saying hey we can get away with Code for Sustainable Homes level 3 – why do we need to do Code 6?

SV – there's not really time to waste

SS – There's the skills shortage that someone mentioned earlier, this is a very big factor I think, if we were overnight to say that every house has to be Passivhaus – who the bloody hell's going to build these things? We haven't got enough people that have a proven track

record of getting those levels of air-tightness, and all the heating energy issues and putting in the triple glazing and M+E specialists

JB – there is a model already in Europe and in Austria for example at the age of 14 you can go into a separate stream in school and become – you can do a five year diploma in timber construction and detailing and come out at the age of 19 with a diploma and be capable of detailing and cadding up a Passivhaus building – I have got somebody in the office who has been through that

SS – A – levels or GCSE equivalent in Passivhaus –

JB – everyone seems to think it is – the Government and the last Government was the same, that unless you have been to University and done a degree you are nothing, and that is just ridiculous and we have lost our technical skills as a result – we all thought we could survive on selling insurance and

SS – and financial advice

SV – the construction industry needs a lot of blame laying at its own door – it abolished apprenticeships a long time ago

JB – well that could... if the present Government

DN – make apprenticeships

DS - there are the 14-19 vocational apprenticeships, and construction skills are one of the skills sectors that are being heavily pushed – so ok we are not there yet, but it is heading in that way but yes to say there is a skills deficit now is – with the Passivhaus we tried to build in the Oxfordshire, with the builder that we used he had never built a low energy building and we failed to get Passivhaus air-tightness standard but it was three or four times better than a normal construction and that was the first time with a bit of supervision and priming someone

to be aware of these details – second time around I think we probably could have done it – I don't think we need to make builders into rocket scientists to take care

JB – we need an infinitely greater number of people who are able to do the detailing and then take that on to the building on site

PS – how scarred do you think particularly that contractors are about meeting these standards cos I have just spoken to Wates recently and they are fairly confident that they could regularly get levels of $2m^3$/ it's a big jump from a couple of years ago when they were getting 7 or 8.

JB – there is a lot of bullshit out there, people say these things they say we have built a Passivhaus and they are not building a Passivhaus at all

DS – no of course not

SV – I think there is a big fundamental problem in that the concept of air-tight buildings did just not exist in this country before - if you were just building a brick wall the purpose was just to build to put up one on top of the other – I think you can train people to detail but there is a need to explain to the people who are actually building it to get them to understand why – you can't just tell somebody and make it air-tight there has to be an understanding of the concept and where it is going to – which I don't think would take very long but it does require the industry itself to embrace the whole concept and communicate it through all levels

JB – If you have to really have good draftsmen and lots of them or you are relying on just a few of us who are taking a real interest in it – you need modelling and so on and try to explain that to someone and you know it is the rest of the world out there who isn't doing it

SV – since when did builders ever look at a drawing? I don't know sorry

JB – that is where it is explained in the plans – that is the barrier to air-tightness and this is what is behind this detail and so on and if we do that around here we are never going to get

enough Passivhauses built we do have to do this on large, large, numbers of people who can do that – whether it is Passivhaus or something similar or SAP or whatever, they need to know how to detail a balcony so that it doesn't leak heat out through the floor and through the walls –

PS – schools of architecture?

JB – well schools of architecture are mostly taught by architects

DS – so are you saying that every school of architecture should have a module on detailing low energy design?

JB – yes but

SV – detailing full stop would be good start

JB – the thing is for someone to be really good they need to do five years solid training that is more than an architect's time –

DS – surely it's not that difficult? Talking about training – it is a simple principle of an air-tight barrier

JB – I'm not talking about that I am talking about being able to deal with detail – say if you have a complex wall junction and it is going to be timber, how are you going to detail it so that it works and doesn't give you cold bridging and it is just making that automatic instead of just – when you think about any of us trying to do the same thing – we would spend 2 days labouring over a detail that somebody like that can do in an hour

DS – I don't think we should be doing that in the first place with young people - what we should be saying is if you do that then you will have an almost impossible detail to solve, if you have had five years training then you would be saying that you have done fundamentally something wrong in the way that you do construction and I think that this also goes back to UK construction and cavity wall construction, it is not the predominant form of construction in

Germany where render and insulation is quite vernacular, you do have render here but if people are insisting on certain things – certain forms of construction in the UK are just not particularly good at meeting the requirements that we are trying to set for them and actually at Ecobuild this year, there was lots of imported new construction systems and I think we are going to have to embrace a lot of that and from when we start designing if its new build

SV - I think that that is quite critical – it seems to me that –for example we looked at some houses in Belgium recently and I was a little bit fearful that there could be this tendency to just take the old designs and make them kind of Passiv – which I thought, speaking as an architect was slightly missing the point, it was an opportunity to generate a new vernacular and I think also that this concept that you can just not embrace the whole volume of the house as the challenge to design it different – you don't just stuff insulation into a building it's not about sticking kind of exciting kit on top it is about a complete design and that needs to be brought out

SS – I don't know if the British public is ready for that, I had a workshop a little while aback – at the EST where we had some major house builders - you say about we have commodified house building in this country – if you look at the surveys that have been conducted, we are just not all that embracing of modernistic and different vernaculars in their homes, especially – I think for commercial properties that you haven't got so much of an issue with it – there is something that people think of as the traditional British build and if you have three quarters of the public who are not wanting to buy these houses, who the heck is going to build them if they can't sell them? And I think this is the problem, I know Prince Charles brings it all to a head in wanting to build all these Poundbury type developments but the average British person does not want to live in a box that doesn't have gables and doesn't have the cosy sort of comfortable British features that they are used to and I think that is a real threat to the whole way that we are going if low energy architecture because we have got to sell the things

SV – well I'm afraid I don't agree with you –

SS – well it's not me – I am saying that the statistics that I have seen and the surveys that have been conducted whether it was at the NHBC foundation who have looked at it – there have been many different surveys showing that people

SV – the majority of people in the UK have never had the opportunity to choose anything different – how would they choose anything different – I can only draw on my own personal experience of going back to - I was project architect on Bedzed, and when we were selling the houses and taking people round and everybody once you'd explained the concept was completely bowled over and there was a high demand and high interest because the benefits of the design were improved comfort, light levels you know it is bright and cheery and all the rest of it and I think there has not been enough on offer in this country as an alternative to accurately say that people do not prefer modern design

Me – Celeste as a planner what have you got to say about public perception?

CGu – I guess I work in central London, even in conservation areas our conservation team will allow modern designs as long as the form and the materials meet with the existing format and I guess in central London we do have lots of people with lots of money that can afford nice materials so you know, we don't mind modern design and people I guess – there is a limit to choice – we get lots of flats and I guess when we think of them, they don't look anything like traditional housing – but in terms of energy, I mean, as planners we are limited in what we can require because Government planning policy says we can't legislate in terms of what material they use, what method of construction they use, and go beyond the building regs so that when we visit renewable, that comes from a different planning statement, and that has helped in respect that the first principle is energy efficiency, but planners do not have the knowledge to understand what is energy efficient – we are just left with orientation, we can kind of deal with windows, shading and maybe solar gain but it should really be in

building regs cos then it has to be done – but then when I speak to building control, they know less than me about energy

Me – Colin what role do think building services have?

CG – I think we are going backwards and forwards here a bit and I think we really haven't got to the bottom of this skills shortage thing, because as far as I can see, that is the key issue – if all the builders knew how to do it, and then if we introduced – when is it 2013 for the Code, is that right, and level 4, apart from the fact that you could achieve it by adding renewables on top of the roof, but you can nearly get there with just the envelope, so if we introduce that and said we have to do it with the envelope, the question still is can we really do it? And I think that I agree with a lot of comments about architecture and training and I also agree that at the trades level there's absolutely no emphasis on working in teams and if you are dealing with a building that has got to meet the requirements, then it is team work. A friend of mine, Linda Clark who specialises in labour, she says there's always a problem where different trades meet, for example you stick a window in a wall and who is responsible for the boundary between that window and that wall so – it can only really work if everybody is on board, we have got some examples of that with the work of Malcolm Bell and Bob Lowe in where is it – it is not Stamford Bridge – Stamford Brook – yeah I keep saying Stamford Bridge, but they had to continuously go back to their contractors and try and remind them what the targets were, in order to get to air-tightness and that kind of thing, so if you could get all of that done, and that is a huge if, then I could begin to answer your question about services, because services are then just a minor tack-on to that because you haven't really got a great deal of problems with the services in fact the only problem then is you are going to throw out all of your traditional central heating and hot water kind of approach you always had and at that point things like air-source heat pumps and if you are going to have mechanical ventilation it can begin to make sense because they don't make any sense at the moment when we haven't just got the envelope right – so I think we are not ready yet for the discussion on building services

SD – the route we are going down is for a modular design – we have got the factory just kind of set-up so that the air-tightness just comes as part of the package, cos everything is cut so precisely with five axis cutters in the factory – the issue that we have is actually selling the modules, who actually wants to live in a modular building

CG- Is this the thing that was on the television? Grand Designs – did you make one for Grand Designs?

Me – I am just going to stop you cos we need to change the tape

DN – on the topic of refurbishing – one of the objections seems to be that it would be hard to meet Passivhaus standard and I don't think one should slavishly believe that that is a requirement, a Passivhaus refurb standard which is a reduced standard which is still something we could go and do because you might be doing relatively inexpensive things like external insulation and just because you can' t meet Passivhaus standard does not mean that is not worthwhile, the second thing we were talking about is what is actually the incentive to go and do it in the first place and I think we have forgotten VAT, refurbishment at the moment is VATable compared to new build which we maybe seem to consider as being less important is in fact free – I think actually it should go the other way round, unless you build a Passivhaus in which case you should get zero VAT, so when I get into Parliament which I won't be standing for, because I don't know how to fiddle expenses – I will actually propose that if you build a Passivhaus you get that reduction and all refurbishment that achieves a lowering of energy actually has a break on VAT. That is the new Cameron philosophy – Brown is dead.

JG – the Government already promises a lot more by having these grants – saying they will give £500 to everybody to pay their bills – they will still have to do this anyway instead of just paying it once for insulation, and talking to a couple of people it seems that they know that this is not effective but it's either that it's not going to be understood by people because there are problems with not necessarily associating insulation with energy bills even if they

know their energy bills are high and in just being patronising – talking to my mother she is highly educated but she thinks oh, you can't tell me what to do – you can't give me £500 and tell me that I have got to spend it on insulation – give me the money and I will decide what to do - it's just human –

DN – Effectively the bigger the project the bigger the saving with VAT, with five hundred quid you are you are not going to refurb a big house, it is neither here nor there but if a 15% makes a huge difference –

JG – so why is Government – I am not criticising the idea, I just wonder why? We are not the first ones to have thought about that – so why is it not working like that?

AP – I don't know, I was just curious actually cos I followed that flat VAT debate years ago for a long time and what I can't understand is that there was a reduction and then it went a bit cold and then

DS – because they wanted to encourage house building because we had a shortage of housing – but housing improvement was a luxury people were just making their homes nicer so they weighted it that way around – now that the imperative is to improve the performance of the homes we don't actually want to be giving it to a house where some people put in a new bathroom but we do,

DN – all we have to do is effectively zero rate insulation

DS – it already is isn't it? Aren't energy saving appliances?

DN – well ok then an allowance for the install – work a ratio of what the install would cost

AP – what we need is an old banger scheme, you know where you scrap your cavity walls in favour for external insulation

JB – the problem with external insulation is or internal insulation is it is all quite difficult you have down-pipes you have junctions between the walls and roofs and between walls and

floors and people tend to take the easiest route it is just human nature it is also the nature of every living species to go through the survival of the fittest that they go through the easiest route and that includes politicians and politicians don't really believe in what they are doing, they are there just to win a vote and they are not going to risk their necks trying to bring in some external insulation policy which is potentially going to be really problematic and so we have to really start with politicians who are not fit for purpose they are not able to cope, most of them are not able to understand the problem – if they understood the problem, then they could understand the scale of the job to overcome it and then there isn't any alternative except for doing things on a bigger scale and legislate and legislate in a way that really makes it very encouraging for people to do these things and help people and you know we are all busy enough doing Passivhaus buildings it's a tiny little thing we all are and the difference between it being almost like a hobby thing and something which is on the scale of UK building or whether it is really rolled out – they can persuade people they can talk about comfort and so on and that works on a one to one basis with a lot of the sort of clients that we have got but it doesn't necessarily work on the wider scale and to a certain extent it does but what about the housing associations and ...

PS – I have had this discussion with people like the large school building projects at the moment where people are seriously considering when building 10 schools in an area, building 2 to Passivhaus standard – they don't quite understand it and they don't quite understand how to influence that whole business model and their whole delivery model but I don't know industry wide what level of stuff they understand but I think it is an issue that is beginning to be taken seriously – they see the benefits, they want to deliver for their tenants low fuel housing, and with large developers if you can make the argument to them then the potential it makes complete sense, and lots of them aren't that scared because they have done fairly air-tight buildings in their mind they also haven't done much thermal bridge free construction, but I guess they are arrogant enough to think that they can overcome it, we are big enough we are brutish enough so right we are going to do this – legislate from the top

and it is going to happen – I can't tell where these projects are on which we are going to have to practice but there is definitely a will to engage with this issue from people who are contracting very large projects, I don't think it is just a cottage industry

JB – the, the, there might be the will but do they have the money – if they are trying to spend or build social housing for £1000 per square metre there needs to be something that pushes beyond that

PS – how much does it cost to build a Passivhaus?

SS – 1350?

SD – In effect if you are mass producing it then maybe 600 per square metre – maybe we can get it down to that?

DS – I am curious about the costs that are incurred when you try to make it look like a traditional house – the problem with the mass builders is that it is not particularly easy to do a Passivhaus with a brick skin on the outside – the brick skin is largely cosmetic, the chimney is largely cosmetic, the eaves are cosmetic so you have paid twice for so many things whereas interestingly affordable housing where they use insulated render a lot already, the premium for upgrading that from this much to that much is relatively small and the cost of getting rid of the wet heating system and replacing it with a whole house ventilation system isn't much either so I don't think there needs to be a huge premium if you work with how you should design a Passivhaus – look at the simple German construction details it is a very economic form of construction – as soon as we start to try and make it look like a traditional house we get quite a lot of cost premium because there is a whole load of redundancy shoved on the outside but I am not sure that price should be an absolutely massive one (issue) but I do think that – it the model is to be developed to sell, they can't find the value in market selling to cover the premium of cost construction – we need to work with people for the longer term interest if we need to look at liability of energy prices or fuel poverty where policy will let us talk about it, then you might get some buy in.

SS – It would be fascinating if you had a housing estate where the social housing which was built to say Passivhaus standard or Code 4 or what have you and then the rest of it was private and then they didn't have to bother hitting any Code level at all and see if there would be eventually some sort of envy for the people who have the Code 4 who only pay a few pounds a month for the heating and the people who have the better supposedly more expensive properties who are paying 10 times as much for their heating bills – how long would it take before they said hold on wait a minute maybe we didn't get the better deal? We may have power showers but my god we are paying for them

DN – I think that as we build more and more – there will be economies of scale – any particular product, when you start producing in 10s of thousands/ 100s of thousands an millions, cost go down in a very steep curve and that of course is where a mass market will lead to improvement

SS – and even in Germany now, double glazing and triple glazing, it's pretty much per square metre the same price – and that didn't take very many years

DN – but that is probably a marketing decision to drop the price and go for volume

SS – and also the fact that they have a higher spec on their double glazing than we do – they have higher standards already

Me – what about people living in them and user understanding of how to live in a Passivhaus

DN - I gather there are 13 houses in the pipeline in the UK?

Me – I think there are more actually

DN – ok – but once there is more of a snowball – there needs to be 50 or so to take off

SD – they are all in the flagship stage – saying this is our flagship

CG – I was speaking to people from a number of MVHR manufacturers and they are saying they are putting a lot of MVHR units into ordinary flats – there are quite a few developments

... So the issue of openable windows which is what we were talking about earlier is already one that people are experiencing but outside of a Passivhaus context – we will get feedback hopefully from that cos as far as I understand it there is no difference from living in a Passivhaus and any other kind of house other than the MVHR

DN – yes you would close the windows on a cold day and then sometimes open them for fresh air – I think this business of people not understanding that you can open the windows will go away when you have a TV programme and explain it by the time that people see it and understand what it is all about – I find that people say, what do I do in my spare time, well I am building a Passivhaus then they say well what is it and I explain to them things like MVHR and heat recovery – they get it pretty quickly – but maybe I have got some smart friends – but seriously it is not rocket science – it just is education on a pretty basic level

DS – then are we making an issue out of it? If it is no different then why are we Passivhaus this kind of curious, mystical concept – this opaque thing

CG – that is why I was saying, if we forget that it is called Passivhaus – say if you are looking at a minimum energy standard like the 0.8 heat loss parameter, something like that right, which is what the Government are talking about in terms of the Stamp Duty business, you know the Stamp Duty – and to meet that you have to have 0.8 or less – all we have to do is to make a name for something like that and you can call it anything you want you know – so

JG – and make this the minimum requirement for Building Regs

CG – yeah, so that instead of going we will meet the the Code by saying we will go to Code 5 and do it through PV on the roof or a windmill, we say no – you have to get to Code 4 with the envelope before you do anything else

DN – I also think that when we have got houses that are superior in their performance, I think that there has to be a brand for them – so let's like call them gold standard – it needs to

be something much.. more different from that but it needs to be something different – like the blue plaque outside your house that says that somebody famous lived there, there needs to be something that is different

SJ – all it needs to be is energy on the EPCs

DN – but I think it needs to be clearer like you have got on the outside of the house, some little plaque – subtle which simply says triple A plus –

JB – the problem is believing it – the building control officer has to know – they don't know their way around...

CG – that's not fair – there are a lot of brilliant building control officers

JB – yeah there are – but there are an awful lot of really bad ones –

CG – there are an awful lot of really bad architects...and building services engineers

JB – for example I had one come to look at a site at the beginning when you are digging foundations and saying as long as you have got smoke detectors we are happy – that is literally the truth and there are a lot of bad ones in-between that – what the Swiss have done with the Minergie system is they have taken.. if somebody wants to go above the standard of their normal codes, they go into the Minergie system and each county has one office of Minergie energy specialists – and there is a Minergie P standard which is near the top of the which is Minergie Passivhaus – you pay your extra money but you get something that is really accredited and goes up on a developers sign board and make people want to buy that building

JG – but that is the Code

JB – but no the Code is...

JG – the Code it has a certificate and it is a tedious painful process with the BRE but you get the certificate which is accredited and there is a post-construction review

JB – but this is already discredited by the carbon – by the zero carbon study – because it has been based on completely incoherent thinking – it is not thought about

JG – I am not sure – I am not saying it is perfect but we can say it is a certification process with levels and – you can be 3 you can be 4 you can be 6

JB – but building control officers don't even know – the main point I was making is that building control officers aren't up to scratch to understand these high levels of the Code and they will admit that time and again

CG – right – but that goes back to our general skills shortage that we are saying that across the industry – it is not just building control who don't know what they are doing – from the architects who design through the builders who build them and those who live in them,

JB – but one way ... so there are two ways of dealing with that – and one is to train – I don't know how many building control officers there are – to come up to a higher standard, or you say we are going to effectively fast track some building control officers – which is a realistic thing – because we can't train everyone up because there isn't enough time – so let's fast-track some and somehow offer some incentives like in Switzerland you know you pay a bit more to have your building certified rather than the standard and that helps pay for someone who has done the extra training

SS – and that what they said in the zero carbon consultation document – if you look at the allowable solutions – everybody is wondering who it is who is going to monitor these horrendously complicated ways of getting to zero carbon – and the big workforce that they are going to draw on to ... building control people, so they are going to have to be educated in some form or other

SJ – but it is also about how you are going to use the building – how you live in a house and how you operate and office building and how you control these things – so it is all the way

from who designs them to who builds them and how they are run – problems all along the way – I guess we have these energy efficiency...

CG – challenges –

SJ – very challenging

SV – I would like to say that I think one thing that is very important is that any Passiv buildings in this country should actually be monitored – you may be able to get them but what you really need to understand is the nuances of operation – I think that the evidence in Germany suggests that once they have been in use after a year or two years, their energy levels drop so that there is obviously an adjustment process – and learning how to use a building and again I think that is something that we have become very unable to do is to accept that sometimes in a building, to get the most of it you need to actually have to work with it, it is not just turning on the heating or turning on the air-conditioning – you have to understand

SS – the BREEAM in use that they have just brought out – any building that is to be seen as outstanding will also have to comply with BREEAM in use – in two years they will have to prove that they are able to meet the targets that were set –

SV – but that information then disseminated around will surely help both people in the construction industry and designers in terms of understanding –

CG – what is discredited by this zero carbon study you mentioned? –

JB – oh I am talking about the fact that the Code for Sustainable Homes has been based on the permitting for off-setting the heat losses by biomass – and if you follow for example Professor Tim Rand, and food policy and land use in the UK – we don't have sufficient land in the UK to grow our own unless we become mostly vegetarian and just have a little bit of meat and then we can grow...

CG – where is this study so I can look at it?

JB – oh the zero carbon consultation? Oh there is a huge wide spread consultation and the outcome – and the outcome of that has been – and the main outcome of that has been that we need to put energy efficiency, not offsetting at the top, so that is a huge shift from the Code thing that has been going on in the UK for the last years or so that is where we need to question the huge amounts of tax- payers money that has gone into the Code – creating something that has been done already

SJ – that is right – this has already been done in Switzerland and Germany and Austria, why can't we just use – I know it is not just an easy transfer – but there has got to be something that we can use in the UK – and as you are saying we have done all these zero carbon studies and re-defining zero carbon and re-defining it again, it's just figuring out exactly what to do, why aren't people examining what has been done and how well it works and using it to adjust our building regs –

DS – nobody in Germany thought it was a good idea to do zero carbon – but it is a much better slogan in politics than 80% or almost zero carbon or something – so they pitched it out there, it was this great 2016 or in Wales even sooner – expecting everything to be zero carbon – it was purely for political capital – for the moment no-one thinks it is a good idea

I don't think there is anyone defending it anymore – yes we have a mature understanding of low energy or low impact buildings across Europe, but we just seem set on this diversion – so the immature market over here

Me – talking about immature markets – what issues are there to do with supply chain?

SS – yes supply chain efficiency

DS – everybody talks about air-source heat pump and the latest triple glazing – Passivhaus certified products are difficult to obtain in this country and we were importing them for each project – but everyone has cottoned on and the market will have to sort that out

SS – what about the SAP appendix Q issues – the difference with MVHR – that there are different ways of testing – at the Passivhaus Institut – so you have the problems that you are talking about ... it is 12% penalty I think that you get if you use MVHR that is not approved by the Institut – so what company is going to pay thousands to go and have it approved by an Institut and then thousands to get it through SAP appendix Q? – So it does make it difficult for somebody entering the market – it's an issue

JB – there is this thing to have somebody who knows about how they test it – I can't remember all the details of comparison between the Institut and the BRE but when looking at resistance and how this effects the efficiency of the unit – people aren't looking across the water to see how testing procedures are being undertaken and learning from that – and why we can't all adopt the same systems – why in the rest of Europe

SS – but we have to do it with the pipes attached don't we – the idea being that there are all these losses that can come about if you don't do the pipe-work so you have a standardised pipe installation whereas in Germany you just do the box and they don't worry about the pipe losses – that seems to be a fundamental difference in psychology –

PS – in terms of the supply chain side, I think that there is a bit of a problem – I also think there is a bit of a fear of getting German products over – some people I have actually spoken to have said well we'd like to do Passivhaus but we'd like everything to be manufactured in the UK – and it's really, really, strange cos they wouldn't ask where their oven came from but they are really, really, interested in where their MVHR comes from – I think the reason for that is that we bring up Passivhaus and we sell it as Passivhaus – and that makes them ask completely different questions than if we were selling it as a low energy building – they get that in their mind – they hear a German word and they just run with it and they have some questions and they do some research on the internet and they talk to someone and immediately they have all these problems which would never have happened if we had said we are going to do a really, really, low energy building – and say leave it to us - then we

would take the issues one at a time – we would take mechanical ventilation, we would take low air-tightness and energy – I do really worry about the branding of it – sometimes how helpful it is – fair enough as an industry, as a fledgling industry – to get us all talking about it

Me – do you think there would be the same issues if it was an American product would people react the same way?

DN – would you like to drive a BMW or an Audi or a Chrysler?

Laughter

PS – I think there is an issue there – in that is German – I think that there is a real issue –

DN – don't all your clients drive BMWs and Audis?

PS – I don't know

DN – I bet they do – can I just comment from just another angle – as somebody who is new to all of this, I find that there is a huge number of organisations there is the GBC and there is a this one and there is a that one and then the Zero Carbon Hub all trying to pull it all together – it does strike me that there are just too many quangos or whatever – and actually there needs to be some sort of assimilation of that and mergers

JB – I think that this goes back to the point that politicians are not fit for purpose – they don't know – even most of them even the fundamentals of ... so they have to keep going out and consulting – trying to get some answers back to really basic questions that we all know the answers to anyway and do need to

SS – and then ignoring the answers anyhow

JB – talking about products – one thing that really kick started the Austrian – in the region of Austria – and really German beating technologies – technology is the second thing that we do after we do the fundamentals – and that was to create the Vorarlberg Institut of Energy, and then to be a member, companies/manufacturers had to open all their trade secrets to

other paid up members of the group and they had to put them on a website – that is accessible to the paid up members – and at first people were very reluctant to do that because they felt they were giving away all their secrets – like where do they get their heat exchanger from and heat recovery and so on – and they gradually realised that this was actually helping another little local company to set up for example a competitive heat exchanger to provide that locally and more efficiently because they go off and study each and every thing and work out how to do it better – and now they have got a really good really thriving manufacturing system and they all have pre-fabricated buildings to Passivhaus standard now and

Me – we are actually running out of time and drawing to a close what do each of you think – can I just go around everybody and ask what you think the key constraints are in a nutshell?

DS – I think it needs to be legislated, I don't think we are going to do it by the carrot method and point 2 maybe we need to sort of demystify it – and just make it a matter of course – just what you do

PS – I think I would say that the fact that the Code for Sustainable Homes exists is a good thing and a bad thing – it has made it harder to get through Passivhaus projects because people are not so interested in them – I also think it is a big hard brand to sell not in the principle but in the name - I think the principle – I think we need to concentrate more on the emotive issues around Passivhaus, more on the emotional arguments – whereas not just carbon

DN – I think we need to have some sort of central organisation focused on Passivhaus –

SD – I think we need to get the cost down, I think from our side mass producing it will benefit

JB – I think we need to have examples – and to help take things beyond the examples we need better politicians

SS – I think in the commercial side we need to work out the disconnect between who's paying to build the building and who's actually going to be using it – with the energy savings being somehow being transferred to the person who is making the capital expenditure in the first place –

SV – I am going to answer a slightly different question – which I think, what should be done to generate that which is for the Government to provide massive incentives through tax in terms of getting existing buildings up to towards a Passivhaus or whatever standard cos that would not only save far greater amounts of energy and carbon, but with the vast numbers it would generate across the country industries and services within those areas via the element acquired for the Passivhaus concept

SJ – I think it is getting the base build right so – that is the education of the ...everyone involved in the whole chain of construction um and focusing on energy efficiency before anything else and providing the incentives and creating cultural change – probably do that through education

JG – I also agree on the education side but for the industry and for consumers and in terms of branding, maybe we should just integrate a similar standard but within the existing one cos that is reflected in the EPC rating and or in your Code rating or in your BREEAM or because we have enough standards here at the moment

AP – yes I would agree with that – we should not hold it up as something unique and niche – it's the terminology and er – but also in education look at it within context – the whole environmental context – not to lose sight of that debate

CG – yeah well, I agree with what people have said – I think training is really the most important thing so that people know how to do it – from professions through to kind of tool box – talks on site – so that people don't lose where they are going – in their rush to make their bonus or whatever – and I think more information also on technologies so that we know what air-source heat pumps do or even stuff like aerogel for dry-lining walls – it deals with

the problems of loss of space, that kind of thing yeah – and you get very low conductivities so I think it is those two things – training and information

SGu – to support the legislation – we need positive enforcement to make sure we are actually achieving what we actually saying we are achieving – and then just education, I think education in general across the population to understand how buildings work – how you need to interact with them – I'm from a hot climate, so I have never been educated in terms of how to keep a building warm – but I think I get the picture, but we do understand how to keep them cool in Australia – so I think we have just lost that in the UK –

Me – Anybody would like to say anything else?

JB – I would just like to say that we don't need to think about ditching the term – to say it is a small thing, yes it is a small thing in the UK but it is now established widespread across Europe – it will be compulsory in Denmark in a few years' time – it's the emerging European standard so I think we ditch our little parochial systems that are proven not to work and we take something which is the emerging European standard –

PS – I think it needs to be a footnote – explaining it, explaining how we get there and by the way it is called Passivhaus and it comes from Germany – I don't think it is the right front to get people on

SV – I think Justin has a very valid point – I think we would be much better off to be linked with everybody in Europe because it then makes literature and marketing of products so much more easier and then

SS – get the Euro

SV – and then hopefully we will get the Euro very soon

DN – I think it is adopted in 13 countries? – We were in Frankfurt and Wolfgang Feist showed a map of the world with 13 countries on it –

Me – I am going to have to stop now

Henrietta Lynch – Focus Group Transcription 20.11.09

10 Attendees –

Me – OK so first of all, could I just go around the table individually and ask you your name, your profession and why you were interested in coming along to this discussion group this afternoon apart from the fact that I invited you.

GL – My name is GL I'm an architect at Sarah Wigglesworth Architects, I'm particularly interested in Passivhaus because we have a big argument in the office about sort of passive ventilation versus mechanical ventilation and air-tightness and I'm all for Passivhaus but a lot of people aren't and I'm kind of interested in what everybody else has to say really.

MD – I work as an architect and I used to work in Italy for the National Institute of Sustainable Architecture, and I am really passionate about this field so I am glad to participate in this workshop.

JB – I'm from the Good Homes Alliance, I am particularly interested in Passivhaus since many of the developer members of the Good Homes Alliance are either trying to build or trying to build to Passivhaus standards. We promote fabric performance as being the key change to make as you head towards low carbon homes and hence Passivhaus is a very strong system or approach that we can use in that sense. That is why I am interested.

CE – um hi I'm CE, my background is mechanical engineering I am interested in Passivhaus because as I see it as becoming increasingly more common and I agree with its design principles and would like to see how it can be used more commonly, yeah.

DH – I'm DH from 3D Reid Architects and I'm an architect and I worked for a long time in Hamburg where there was much more of an appreciation and a use of Passivhaus systems and I haven't seen or heard much in the UK. I took the opportunity to find out why, and I am trying to work out myself why we don't use the same systems and ideas.

BB – Hi I'm BB from WB Associates and the Useable Buildings Trust, we try to look at how buildings actually work and carry the messages back we are very interested and have worked quite a lot on European projects over the years and sometimes there are cultural rather than technical differences why things that work in one country don't work in another so I am very keen to try and understand more about Passivhaus and how we bring it into this country particularly in non-domestic buildings where often the building services mess everything up.

DA – Hi I'm DA from the Zero Carbon Hub seconded from Knauf Insulation so I am part of a small private, public erm company that is set up to help the Government deliver Zero Carbon homes from 2016. As such Passivhaus is one approach to looking at energy efficiency of homes, clearly to get to zero carbon you have to add low and zero carbon technologies and potentially add allowable solutions as well – what I am interested in is understanding this particular – I would probably describe it more as a philosophy and that approach so that I can learn more really. Thank you.

MT – I am MT I am an architect currently I am doing my PhD at Oxford Brookes University. I have an MSc in energy efficient and sustainable buildings and in my thesis in 2007, I have modelled the 1930s semi-detached, the refurbishment of the 1930s semi-detached in the UK and through the Passivhaus principles and standards so I am very much interested to meet other people who...

PS – Hi I am PS, I work as a consultant at Inbuilt and I am working on a number of live Passivhaus projects – some fairly large schemes in the housing sector and I am off to Germany to go to the Passivhaus Institute in two weeks for a three month secondment there, sorry a three week secondment there – three months would be horrible! – So I am generally interested in the subject and am keen to find out what everybody else thinks.

RC – Hi RC, I work for a company called Camco, which used to be Energy for Sustainable Development. I am very interested to see how we can live without fossil fuels in the future and see Passivhaus as one of the solutions – I am interested in the tension between Passivhaus and Active House to see which one is the right option.

Me – thank you, at the end I will collect all the forms that you have filled in – I just wanted to check with everybody that you are alright with having your email addresses circulated to one another after this. For the next part, I would like to keeps things in quite succinct sections, for the next section I would like you to have a c. 20 minute discussion which I won't really intervene in unless to stop you talking over each other too much so that I can't hear you – this is basically taking the statement what do you think the main issues effecting the uptake of Passivhaus design in the UK are? So I don't know if there is anybody who has any particular thoughts on this to start with who would like to kick-off? Otherwise I will choose somebody... it doesn't matter there are no wrong or right answers to this by the way. Bill...

BB – Um what I find is that you know that in Britain we regard doing things well as a bit too stretching and so there seems to be a lot of push back on Passivhaus envelope standards because essentially, you know, we don't build things properly and we can't build things properly and the only way to get out of that is to build them in factories rather than create

skills for building them on site. Then there is the area, people come up and say this is all too Germanic and it pushes things too far and actually a more relaxed standard would be better because the odd little bit extra use of fossil fuels doesn't really make very much difference, and then as I mentioned at the beginning, there are lots of services engineers who rush in and can often over-engineer things so that actually the heating bit of Passivhaus – even if we sorted that out – is actually the tip of the iceberg, in relation to all of the electrical stuff, which can even include the MVHR sometimes, so there does seem to be a big sort of, it's partly a poverty of aspiration, but it's partly that we have come from SAP, and a thought which is also in Government that we have to put on the green bling rather than you can actually drill down much deeper in actually getting rid of demand by passive measures and the problem it seems to me is that to get these things to work it has to do what it says on the tin, so what happens is people have to do things properly, and then you can sacrifice your margins on the engineering services and the engineering services things do things properly, but this is such a difference away from current practice, it's how do you make the step-change? How do you make sure that the innovators and pioneers can actually get it to work so that other people can follow?

Me – anybody else have any thoughts on those comments?

JB – it is important that the culture in this country of doing things to high quality on any kind of building practice really erm, but particularly on the low energy side of it, I think is quite limited, I think it is quite poor, and so it isn't really within our culture to do that. Erm and the number of comments you get back about trying to create, the worries about trying to create very air-tight buildings for example, everybody is used to having leaky buildings and thinking that is part of the natural ventilation strategy so there is a strong cultural difficulty with this approach, I think but we are probably going to have to change, but backwards looking I think it is a big problem, but then there are so many others as well, I almost found it impossible to write down what the barriers might be on this, well it is everything, the skills, the training, the tools, the knowledge, the awareness, the interest, the targets, the regulations, it's just like where do you start really, so

Me – um George, you spoke initially about conflict between people in your office and ideas that some people felt that natural ventilation was the right way to go...

GL – I think that some people in our office, they don't see the, they look at the two in isolation so that they don't look at energy and ventilation as one thing it is sort of how do we ventilate the building then how do we heat it, and they are two separate things. I think another thing that we find a lot that clients and in a way, design professionals also do, they use things like BREEAM and the Code for Sustainable Homes as a kind of lets clear our

conscience of sustainability and so you do that and you have ticked the box and you don't have to do anything else so why would you do Passivhaus? Which is not really the right attitude, but it is the way it is unfortunately.

Me – do you find similar thoughts or thinking at Inbuilt for instance? You are a firm of engineers as opposed to architects.

PS – Yeah I think there is a sort of, yes even internally in the company there is a lot of teaching each other about sustainability and what kind of approach you are going to take there are a lot of issues there, there are a lot of people there, (and we do a lot of Passivhaus work), who are dead against it, they think that natural ventilation is a much more sensible approach, um but I think that simplifies it and Passivhaus buildings aren't mechanically ventilated buildings they have got a mixed mode ventilation systems, typically they are naturally ventilated in Summer, and we could design a Passivhaus where people can't open the windows, and that is a terrible thing to do, and it is going to end up being very uncomfortable. So a lot of the debates around it both at work and generally seem to be a little bit narrow but the principles are quite sound, so thermal bridge free construction, call it Code call it Passivhaus is a good idea, reducing air-tightness at least to three and below it seems like at least we can get consensus about that, so a lot of the methods, a lot of the approaches that are taken apply to both Passivhaus and good low energy buildings so I think it is important that we separate those from the German calculation methodology and how we approach them.

Me – yeah,

RC – I just want to sort of reinforce the cultural aspect of this, um just thinking back, the history, there were Passivhauses built in Milton Keynes, I think it is at the beginning of the 1980s er is it Five Mile Ash, they achieved Passivhaus standard, I don't think it was called Passivhaus in those days they were monitored exhaustively, they were, one of my colleagues were I work you know, worked for Feilden Clegg who designed them, he lived in them with his family, he enjoyed living there, the energy benefits all came through, so they were the pioneering examples and were proven to work and I would just sort of posit from that, that there wasn't a demand for them. I think you know that what people ask – why bother? Energy was cheap, they might have been more expensive, the supply chain issue is because these houses were basically imported, erm we are starting to ask the question now because, what is it 30 years, I can't believe it is 30 years later, we're wondering how we are going to cope with the shortage of fossil fuels

DH – just as an architect, a couple of weeks ago, I was up in Leeds and to me it is very clear that there is a materiality issue, that is tied in particularly in England with where the brick has always been you know that semi-detached brick house is the dream and my experiences in Germany for example and across Europe where timber frame has been much more common historically, and the advances have come through that and they are just accepting more modern ways of doing external envelopes, and I think that we always have to have the brick facade that may or may not be poorly built, but the tradition is one direction and other countries have a different tradition and I think the comment that an example I saw last weekend ... a very smart Ecotown project that I literally drove past and within the car the architect said that looks really great considering its location and it is probably social housing and we all had the tick boxes as architects and the non-architects in the car were like – it looks like a shed. And I just think if this shed-like status is a badge for eco-homes or Passivhaus or the new approach then we have got to re-address that badge and I think that is always an issue and it does interest me in how we promote it not just by its energy levels but as a physical manifestation as to progress and things, I think that that is the big hurdle.

Me – you worked on the 1930s or were working on the 1930s UK semi-detached - bearing that in mind, what were people's attitudes to the aesthetics of low energy building I mean how is your work progressing in terms of ...the showing the potential for re-furbishment?

MT – It is a mixture of responses, it is mass production building the 1930s semi-detached, what I have defined is there is a lack of solutions in the UK, in Switzerland for instance, re-furbishing houses of this age – they have prefabricated solutions, where they take out the roof they replace the roof with integrated mechanical ventilation, so there is a lack of solutions in the different types of the building stock in the UK and unfortunately we don't have monitored examples, we don't have refurbished and monitored examples of the building stock so there is a lack also of the information as a feedback how they perform. It's only the modelling, only the...

Me – you were smiling about that...

DA – yes, I agree with a lot of the points made, erm for me we have got a history of cheap gas, there were a few enthusiasts who did some interesting work, it didn't become mainstream and really until the last few years, where many more serious people are seriously thinking about it but then, there's a lack of examples so if we are thinking, it is a bit Catch 22 for someone to demand this they need examples, for examples to be built there need to be people who know how to build them and a supply chain and there is no easy way around that, it takes time to build up some momentum, back in Germany 15 years ago there weren't many either, it has taken a long time to get to the build rate which is still isn't very

high, even now, what a 1000 a year perhaps there aren't many but in terms of issues affecting take-up these are just normal transition issues of moving from somewhere where it was unknown to now we have a problem set, we have low energy, however it is described, whether it is full Passiv or combinations, the challenge is there and it really helps having high fuel bills, to focus people's minds on that there might be a better way.

JB – I think the point about demand and aesthetics is well made, it is just worth noting maybe that thinking about the methods of construction that are used and whether that that does actually lead to the solution, so in theory the Passivhaus approach would lead you to a Passivhaus solution but in practice for example, the Leeds Met who have done most of the best monitoring work that we have found it doesn't really matter whether you are using brick or SIPs panels or timber cassettes, you still find at least 50% worse performance than you think you are getting no matter what kind of system you are using, so that kind of, so it could be that they are prototypes and they don't know how to use the system and it's the first time and all that kind of stuff, and it isn't Passivhaus approach it is just low energy but even if we do head towards something that looks more like a shed, it does not mean culturally that we are able to build it any more efficiently than anything else. The latest one that Leeds Met have tested was a semi, I think built in SIPs panels, I think that is right, and they said that it performed worse than a 1930s semi as an average performance across thermal efficiency across the walls so we just need to think about those things, so I think that the technical performance and how we build them is almost quite separate from the aesthetics and the demand for them and we are not great on either side at the minute, I don't think.

DA – but I'd add to that its only now that we only know that yeah, no it meaning we are talking about it widely or starting to widely, individuals have known, nothing came from it, I am perhaps now a little more confident that that knowledge will turn into some more applied action to actually work through these – it is something that we are perfectly capable of doing, even if we have to copy some of our neighbours sometimes.

Me – so you think people were just not interested before?

DA – I think the bulk house building model means that they deliver what they are asked to deliver and low energy or frankly any energy performance that actually delivered what it says on the tin wasn't one of those criteria. So spending extra to do that where's the business case? Yeah now some organisations, Jon's, Robert's etc. did take care but that does not create a mass movement overnight, so I think there is a lot more focus and interest there. We have still got a long way to go. But I think that that is a big change over the last number of years.

PS – the basic reason Passivhaus is not so popular in the UK is because, it's that, our drivers are Carbon based whereas theirs are energy security based because when the standard was initially developed in German it was more about fuel conservation than it was about climate change so initially the Government response and industry's response is to come up with a zero carbon home rather than a very, very, energy efficient home which they then make zero carbon. It's the Government; does anybody know or have an opinion as to whether that is likely to change? Since fuel poverty and energy security are bigger drivers now...

RC – I just want to say one thing that hasn't been said yet, maybe because it is stating the bleeding obvious but the climate in this country isn't as severe as it is in Switzerland and Germany and Austria, Scandinavia, we don't have minus 20 degrees in Winter normally so I think that fundamentally that is why there isn't a demand, or hasn't been

PS – well I am inclined to think, well erm Passivhaus is climate specific as with any other building energy modelling so you input your climate data and out-comes a spec for you,

JB – you mean in the tradition of us being um of keeping the weather out rather than necessarily keeping the energy in whereas those in Germany and Austria have had to keep the energy in and that was a different driver to...

RC – it's a thermal comfort issue, and if you have got minus 20 degrees outside, you don't want that really cold air leaking into your house and if it is only nought degrees you put up with it

DA – if I could pick up on the Carbon issue, I think that that is a bit of a red herring because it is relatively only recently that even Carbon, it was only in the 2006 Regs that it has focused on Carbon, although in the last few years there has been a lot of discussion about Carbon and I declare an interest here because I have just chaired the group looking at the energy efficiency standard within the zero carbon definition, so we had a lot of discussion about where do you set the line in terms of minimum energy efficiency as you know that would be part of the definition it's just that the line hadn't been drawn and whether for every single dwelling in the UK you could set Passivhaus standard as the minimum, which you could do, so I think that there has been some focus on Carbon, so I think it will come back to energy efficiency but a lot of this is people feeling their way and exploring different solutions and finding out what works and what doesn't work in a design sense recognising what Jon also said this is fine, this is a definition in terms of design, how it actually performs is also incredibly important and not currently captured

BB – I think there is a sort of cultural institution in economic dynamic in the UK which is interesting to explore a bit, a lot of good things happened in the late 70s that were triggered by the 73 oil crisis that was including 3 Mile Ash and things like that. Then we had 79 which was a shock, but then we had Thatcher and North Sea oil and gas and the whole thing went away from us, where you find in Sweden and Denmark in particular, they were completely driven by reducing their dependence on imported oil. So you know this energy driver was really important, you know Germany picked up a bit of that as well, of course it was rather later there as well and other things came along to do it, but also the Robert thing was that if you find there is something really important to you in a particular culture you do that well and cold countries are quite good at keeping the heat in and also things like MVHR become very different in their cost effectiveness cos the colder it get, the harder a system works but it's the same system so you get you know, a much more no brainer payback, whereas if you put an MVHR system into a leaky building then there is no point in having it. So you get all these things which are building onto each other but I think one thing which has also been dreadful in the UK has been the deskilling of Government, so Government has actually outsourced and privatised everything and it doesn't have the sort of institutions which in the 70s and 80s actually got the information, I mean we used to have the Gas Council that actually did good work we used to have the Electricity Council which actually did good work, BRE did good work in the public interest, all these sort of things they have gone, so the whole thing has been left to the market and the market can't see it for reasons we have already described, and so somehow you have got to know it and you know a few enthusiasts were not enough to knock it on cos it wasn't important, because fuel was cheap.

Me – Robert you were...

RC – yeah I was just wanting to follow on from David's comment about Carbon coming and waning and energy efficiency waxing again because as the grid carbon intensity starts coming down, then carbon will end being a useful metric for the energy performance because basically if you have a zero carbon grid, you will have a zero carbon building potentially but it will/ could be hopeless at energy efficiency

JB – it almost feels like there are two questions, it feels like there is a question going backwards and how we got to how we are and the next question is, given what we are doing, and the regulations and targets that are in place, including the de-carbonisation of the grid, or potential de-carbonisation of the grid, then erm is that going to take us to a point where Passivhaus could be delivered across the patch, as a mainstream endeavour in this country and would that be a good thing? It almost feels like there is a separate question completely rather that how did we get to the mess we are in really... what do people think about that?

BB – What we see when looking at buildings in use is that the enemy of good performance is complication and what I see looking at the national energy strategy is that at the moment we are not going to de-carbonise our electricity supplies and the policies that we've got are likely to actually put the carbon up before it starts to go down so you have got to do what I call a multiplier effect you know you reduce demand you increase efficiency you take the carbon out of the supplies – you have to look at those three elements and Passivhaus is a very much reduce demand thing just getting rid of demand, you know you don't have to use any kit you know increasing efficiency goes on to kit – we at the moment have category error we confuse reducing demand with increasing efficiency we call it all efficiency we can reduce demand by passive measures and behavioural measures and all sorts of other things so what happens it seems to me is in a much more energy and carbon constrained economy, you can't afford not to do something like Passivhaus on the fabric because it is robust, I have a slight concern over a dependence on MVHR, if you could have a robust solution which didn't have a dependence on MVHR that would be even better because what we find is that lots of mechanical things end up broken now ideally MVHR is mission critical you know if you replace the boiler with MVHR so that is the only system, people are quite good at keeping their boilers working they might be quite good at keeping an integrated MVHR system working, but if you have more than one system one of them may end up broken and this can be a problem

Me – yeah, David, no? Yeah Chris

CE - I wanted to second the kind of drive towards MVHR, not only it breaking but it actually requires for quite a lot, for the users to change things like filters every three months, I think, things like that, that is a lot more work than they would currently have to do for their own boiler system, so participation, it requires a lot more participation on the occupants part, I think we are potentially driving fast towards MVHR without looking at the complications further down the road.

Me – I am just going to interject and say that I have seen various Passivhaus developments in mainland Europe where they have a servicing strategy to accompany the MVHR installation so that they get, so you buy into a service contract where people will change your filters or help you with that side of things ... that's all I am going to say

CE – there are some that do that here

PS – working on developments, I am not working on any private developments, but on quite a few social housing ones and we position the MVHR so that it is accessible from the outside because people don't want to be coming in every time and opening those doors and

knocking on those doors and the maintenance costs for those would be huge and so I think you can design over those things private development is very different, if the people aren't choosing to live in a house with MVHR, they are buying it and they don't necessarily know about the systems, I think you will get problems with maintenance, I think you will get people not changing those filters – we can communicate some things really, really well, like drink drive adverts, people are very good at communicating things but in the building industry it seems like we are absolutely pathetic – why don't we have a nice snazzy website with a video showing someone what to do with it? Why don't you have user guides which actually look nice and you'd want to have on your bedside table? I don't know, at the moment its seems like you print some stuff out, shove it in the drawer when you leave and expect people to understand how to use their home

CE – the tendency is to hide services away as much as possible, so MVHR units, a lot of them are shoved up in a loft, no-one goes in their loft so they are not going to change the filter

Me – do you have any sort of comments about communication?

MD – I just want to mention some issues – we need to understand what means education, sensitivity and formation, it is a long process about all the problems regarding Passivhaus it must be able to be built as well so in this way it is sometimes difficult to find the people to do maintenance or convince some client to use like low technologies, so low material, because they really they don't know, they don't know what means low material? Where it comes from - the main thing is to educate people at the first at the beginning at what means sustainable, what means to install the wrong one, to face the impact of their carbon emissions, so I think...

Me – Robert I think

RC – yeah I have got a little experience, I am just in the process of putting an MVHR system into a house, my own house, and I would reinforce what Henrietta is saying that there are people out there who provide a computerised follow-on maintenance service, for things like filters I just wanted to say that I wanted to look a bit further ahead and one point about changing the filters, you said changing the filters every three months, I think that they are probably in quite a dirty environment if that is necessary and once we all get into electric transport then the atmosphere could be a bit cleaner so that could extend that time, but just coming back to Bill's point, so in terms of the maintenance of MVHR systems and the problems of getting people engaged with that, in my mind, one of the key aspects of the houses that we build today, is their resilience, you know, what is going to happen in ten or

twenty years' time? When we have more regular power-cuts or you know there are lots of scare stories about gas being switched off or all this kind of thing, how resilient is your house going to be and I think that potentially the Passivhaus has got a lot going for it, obviously if we lose the electricity, the MVHR goes off, but you can open the window you can probably live in that house for a week before you start really suffering whereas, the house next door which is not so well insulated and can't control the ventilation, they are going to be suffering in five hours

Me – you've got one more thing – I am going to have to

GL – this is sort of stepping back a bit but, we find for us as quite a small architects, one thing, the real problems with trying to get people to think generally about sustainability and sustainable design first is that the kind of process to procuring buildings in this country especially with the economy the way it is makes it quite tricky to convince people that that is the right thing to do because a lot of time you either go through a competition process you have to win it, something, some projects anonymously, and people are just, especially if you are just doing a design to win a competition, you are showing something to somebody that is just a flashy picture and then you get to building the building and then by then you have already won it and they say why do we want to do all this sustainable stuff, you have got the job what is the problem, get on with it, we haven't got enough money, just do it and everything just rushes through, the consultants that you don't necessarily select to work with aren't thinking in an integrated way right from the start so, unless they are somebody who is really driven to push this thing, it is really difficult and so by the time you reach planning stage everything is done and dusted, there is no way back, and you are kind of a bit stuffed really, I don't know what the solution to that is but...

Me – do you have something quickly?

DA – I was just going to say, I think one of the solutions is demand, and you can't invent that overnight and if you look at the challenges that all the political parties will be struggling with over the next ten years there has got to be a huge change in householder attitudes and preferences across a whole range of different things otherwise we have no chance in meeting the carbon targets that have been set or frankly or the whole range of other targets inclusive of reducing risk from energy security etc. etc., I think that that will play into the psyche such that the demand from a competition is driven to be well that's what you say that is what you are going to deliver and that is what I expect ...and that will provide a fundamentally different playing field for all of the professions and those that are able to respond to those changes, by the way when they occur, I am not going to bet my pension on yeah, but that will start to pull through a different ask at the moment, most housing is utility in

the right place that I can afford yeah, so the whole business plan behind a house delivers the wrong product, well actually it is the product that we are asking for yeah, so we have to change what we are asking for in the widest sense.

GL – I just wanted to add to that that there are probably two stages to that there is the asking for something and knowing what you are actually asking for in terms of saying we want Passivhaus and you do realise that that means this? Oh I didn't realise that, so you revert to something a bit less and it is a kind of skilling up of the client organisation or whoever that might be and regulation that allows people to understand what it is they are actually going to get

JB – that applies to different things for different sectors, it means that the housing sector, particularly private housing will be quite different from say schools or health-care buildings and new build will be quite different probably from the retrofit and probably different drivers and different approaches are needed to draw Passivhaus into common usage in these areas, I think I got the impression that you weren't talking about a private house project...

DA – I think it is worth saying that Passivhaus will compete with other solutions and at this stage I am extremely interested to understand the principles and where that is going, having literally just worked through three months of all kinds of different assessments to understand where to set the national minimum energy efficiency standard, obviously we had some very interesting discussions about Passivhaus its benefits and also some of the disadvantages across nine different criteria so how this unfolds in the next number of years will be extremely interesting what will be certainly clear is that everything will have to improve and the ambition, the design ambition will have to increase, but quite if there is a winner, I suspect not, I think multiple things will come forward, it will be interesting to see how things unfold

JB – I would just like to make a comment slightly that if you say that Passivhaus is better than say 25% in terms of the kilowatt hours per metre squared energy targets say for a house, lets pick that and if we say that that target, that kilowatt hours per metre squared target is what we ought to set, as a requirement, and there is this well-developed methodology that is being used for 16,000 properties across Europe, it has a supply chain developed and it has a body of evidence to show how these buildings work, how many people in Britain do you think would actually choose to adopt that, or would choose to go off and do it their own way to get to that target some other way, without actually using the system which has been tried, tested and prescribed, it is my feeling that we just like being a bit maverick and a bit different and a bit eccentric and my feeling is that the majority would just go off and do their own thing anyway, if we don't prescribe a set of solutions I mean

everybody, I am not saying we should prescribe, I am just saying I am just trying to imagine what people will choose... there you go devil's advocate

Laughter

Me – Bill's hand up was kind of first

BB – I mean, I am very worried about prescribing anything because you tend to get, you tend to starve out innovation and lock yourself into things if you prescribe too much now what we used to have in the building regs which I think was rather good is you had deemed to satisfy, trade-off and performance base, you could do it either way, it seems to me that you could lock Passivhaus down as a deems to satisfy, this is a way to do it and you would get what it says on the tin doing that, but what you don't want to do is to actually starve out the other two options, because somebody might come up with something cleverer and simpler and that sort of thing, and there is one big danger of which has certainly been warned about, I was at a conference on building pathology twenty years ago and the Swedes were there and they warned about the ventilation mafia and they felt that they had got too dominated by the need for mechanical ventilation with heat recovery when they ran up against air-quality problems and there is an area where there are lots of people who make ventilation kit who would just love it all to be mandated and it not allowed to have natural ventilation and this could be really bad on the innovative side, but nevertheless as a deemed to satisfy why not? If one could actually get a supply chain, that produces stuff that actually does what it says on the tin at that level then fantastic...

Me – we had a row, I think going around the corner of people's hands up

MT – I would like to add on that how do they know people, how to interact with all this Passivhaus strategies and do they know how easy and are they educated how to have a cross-ventilation and this is something passive and so it's we have to see it's also another part which is the behaviour of the user, how educated is all these people, green people, but they want a Passivhaus, do they know how to interact, do they know how to drive their Passivhaus? So this is another issue that I think that is the education and the information how is?

DH – I think the thing that we are seeing is that I am seeing in the last couple of days is that offices, service departments and in some ways for residential, is that the monitoring systems, is that things are becoming much more monitored whether it is just to see what the fuel costs are or, at the base level, let's just say it is to find that to find out how much the fuel bill is or how much water people use and I think that when it comes down to the home

owners saying, chatting with the neighbour and saying I spent £40 last month on something and he says why I only spent £20, it will be what have you got that I haven't got? And I think that is where possibly demand starts to change at the moment it is um where the technology is more focused on lighting and control of that with a view to not paying for lights that you don't need, but indirectly the turning the lights off, and it all comes back to energy driven by costs and I think as soon as we monitor more private residential then that would be a very big driver

JB – that applies equally, sorry not to interrupt, but to interrupt, but that applies equally to the non-domestic sector as well so we were looking at the monitoring of six health care buildings that have done some kind of re-furbishment work to include some kind of energy performance improvement as well and one of the ones we looked at was a 2003 PFI project so a big one fairly recently completed, should have been built to pretty good low energy standards, um a lot of the minor improvements or what they would think as minor improvements say to the landscaping immediately surrounding the building hadn't been completed and that meant for example that there was bare concrete, there which was reflecting heat or gathering heat and then reflecting the heat into the building whereas if there had been planting around the building it would have been able to absorb some of the heat and give a cooling effect and cooling benefits and they just hadn't understood, like your point about are they driving the building, it has got an FM team whose job it is to manage that on an on-going basis, it just didn't understand how that minor thing could affect the performance of their building on an on-going manner, so the more monitoring and the more understanding of how the buildings actually work applies to all the different sectors

Me – Paul you are going to be the last one in this bit, can you go back maybe to the maverick stuff or have you move on from that?

PS – I think that is absolutely right in terms of our levels of understanding of the design issues and the design running sustainably inherently almost, which when I have spoken to people in Sweden they have spoken about, I have come from the forest and we are used to designing for these extreme climates so it is almost natural for them to do that, I do feel that in the UK we are very susceptible in getting caught up on the latest terminologies be it the Code for Sustainable Homes or suddenly that is a sustainable building now or Passivhaus that is a sustainable building, whereas what we actually need to do is learn the techniques for minimising energy whatever we call it so I think again I will come back to a thermal bridge free construction knowing how to make a building air-tight and then choosing to aim at a level instead of hitting whatever happens accidentally, I do on a separate point, the biggest barrier to Passivhaus are the large house builders and they don't want to change the way

they build buildings they have got no, they have got a vested interest profit-wise in – they do not want to change the way they build their buildings, they want to maintain their supply chains they do not want to pay for prototypes, so inevitably they are going to lobby and act in a way that isn't in the public interest in terms of house-holders and in terms of long-term fuel security of the nation and I think that that is an important thing that one needs to over-come it does require, if you get down to those levels of air-tightness and levels of thermal efficiency that it requires a different way of building, so I think that that is quite a big barrier to the whole thing and also I think we need a non-for-profit organisation in the UK not the BRE which is a trust but acts very much as a profitable company , I heard, someone told me that their aim as a company was to be feared by the completion at one point which I think tells you quite a lot about whether or not they are actually acting in the interest of the majority, the Passivhaus Institute is a not-for-profit organisation driven by very strong leadership by someone who is very passionate about a subject and I think we need to replicate that in the UK if we are going to get a sensible discussion about the subject ... three points

Me – ok, unfortunately I think we could probably go on all day and probably for even longer than that but because of the time constraints today, could I just go around each individual person and ask them what now, after having that discussion they would think is their one main key issue that they think is affecting the uptake of Passivhaus design in the UK? Perhaps starting from this end?

RC – I would put my finger on the cultural issues, a couple of points that haven't quite been made, if you go back thirty or forty years, it was actually, there weren't that many houses that had central heating systems, and that became a sort of mod-com that everybody expected to have eventually and that I think that now up to 80 or 90% have got central heating and we need to educate people that a Passivhaus has got central heating it is just it is a different kind of central heating and I just thought of as ancillary to that that I've got a memory that one set of building regulations or at least one required new houses to have a chimney because the government feared that we might need to keep the, you know have the ability to throw coal on the fire to keep warm and I think that that has long gone from the building regulations but it demonstrates how

BB – I don't think it is that long gone

RC – Is it not? It sort of demonstrates how, our inability to think that far ahead

Me – Paul

PS – I think the biggest barrier is the Code, we have already got legislation that when people say they want a sustainable building then that is what they turn to and if that is not prioritising the most energy efficient design then you won't end up with something like Passivhaus

MT – one point in addition to the barriers on the building sector, how educated are the builders? And how educated are the users of this

DA – I think the biggest thing for me is just examples, I mean, everyone is used to, around this table, the name public, not, let alone what on earth it is like to live in one and of course the press like bad news so, you need quite a lot of really good examples such that people start asking for it and again for me the Passivhaus is a solution here, I think it has merits, I think it has some disadvantages, we are where we are in with the buying public that we have got and they need good examples to be able to understand what to ask for

BB – Well I was going to say very much the same thing, and I think one of the ambitions of the Passivhaus Institute in the nineties was that nobody should be more than 10 km away from a Passivhaus so that just as the idea of having robust examples so people can say, I want one of those to go and see it to talk to the people, but how this supply chain, and I am not sure how we are going to get this supply chain out of the existing house-builders, I think they are dinosaurs, I think it is going to come from somewhere else.

DH – I think it is probably the education, both to get the builders and people producing these houses but also a demand for them, maybe that comes from larger public buildings and people develop an understanding through their school for example or something of that nature so that then so that ten years later or however many years later they think well if I can replicate the same in my home, then that may be a way forward – it's the education

CE – I find it quite hard to separate the cultural, financial, regulatory, I think one really depends on the other like demand is very much dependent on a financial imperative and that is what is ultimately going to change their culture as well as demand I say everything but technological

JB – yeah it's hard isn't it, probably all of the previous and on top of that I wonder about the skills in the supply chain to be able to build this and the culture of and around skills in our sector, I think probably that I don't think the house builders are going to be the people who go about building these, it is going to be built in a different kind of way with people who have different expectations rather than expectations of people going on site with bricks and fitting them together like a mecano set it is going to take some different people I think, but quite how you get that transformation to happen? It has happened in other sectors in terms if you

think about you know IBM and computers and the people who started out saying you know no-one is ever going to want a laptop or a computer at home and then other people came in and did it in a completely different way and looked at it from a different starting point, so I just wondered if that will be something that will happen

MD – yeah I think a good start would be to prepare a small programme for the schools to educate children about the importance of the water, light, environment and green in simple ways so later on they can have a kind of thinks about sustainable way

Me – George

GL – I was going to say that beyond the kind of economic incentives, I think the kind of culture of working in design practice with other professions isn't geared up to this yet because you get as an architect you get taught in isolation, as architects, you sort of work in isolation from the beginning of the process, you are not, this needs much more kind of interactive design thinking really right from the beginning and then carrying on into working with the builders and knowing how to work with them to deliver what you actually set out to do, I don't think that completely exists yet

Henrietta Lynch – Focus Group Transcription 04.12.09

7 Attendees –

Me – I will contact you if I use the film or what you say for public presentation...

The subject that I am going to ask you to talk about today is – what do you think the constraints to the uptake of Passivhaus design in the UK are? It is very loose, but I want to keep the conversation flowing so I might interject at different times, but when I have done this before, generally people have a lot to say anyway talking amongst themselves, if we can try and just speak one at a time and first of all I think the best thing to do is to just go round the room and if you could each introduce yourselves, say what your name is and what you do and what was your interest in coming along to this group apart from the fact that I actually just invited you here today...finally thank you very, very much for coming, it is really appreciated, this is part of my PhD research for which I am looking at the opinions relating to the uptake of Passivhaus design in the UK. So do we want to start with you Paul...?

PB – I'm Councillor PB here in Camden, um I guess I became a Councillor because I was particularly interested in design and the Kings Cross development, I have been very active on the planning committee ever since I joined three and a half years ago and I have also been in effect number two on the sustainability task force where obviously I first encountered Passivhaus

LS – My name is LS, I'm an architect and Partner at Sustainable by Design we were recently finalists in the Welsh Passivhaus competition, I have been interested in working in low energy design for about 20 years, I have been sitting on the building regulations advisory committee, particularly in chairing committees about sustainability and energy efficiency regulation, I have been on that committee now for eight years and recently contributed to the national energy efficiency standard of which Liz was also a member

LR – hi I am LR, I am the appointed managing director of Passivehaus Buildings a new not for profit – our aim is to be a centre of excellence for new low energy and low carbon buildings in the UK and I am an energy expert and a climate change strategist and I get involved in quite a lot of policy things, I was running Carbonlite which was the AECB programme for energy and carbon literacy for the built environment

CO – my name is CO, I came two years ago to the UK and I am really interested in all this kind of Passivhaus development in the UK, cos I studied in Austria in Innsbruck where

Passivhaus was completely normal or almost standard, yeah and I just find it very inspiring and sometimes a little bit frustrating and originally I am from Luxembourg and as I child I just grew up with energy efficiency, my dad told us about this stuff and I am doing at the moment the Passivhaus planning planner course and yeah and that's it

JH - I'm JH, I'm tutor on an architectural masters at CAT and partner is a small building consultancy firm dealing with the built environment and environmental design things and I think I just got into Passivhaus because of that cos of studying and seeing it as one of the ways forward for a low carbon future

BC – Hi I am BC and I am also a lecturer at the Centre for Alternative Technology in Wales and I have been teaching there for nine years, I am also director of a charity called RESET, Renewable Energy and Shelter, Environment Training and we run training on low carbon processes around the built environment, building, renewable energy, waste, water and so on and I am hoping to bring Passivhaus training, aspects of Passivhaus training into the work that we do, we are based in London and I also teach in Wales and before that I was an architect and before that I was a builder and came to CAT as a builder so I am very interested in the actual practical processes of Passivhaus and how it affects the building trade and what kind of skills people are going to need for that

SB – I am SB and I am an architect by training and I've had an interest in sustainability and about seven or eight years ago I retrained and did an MSc in climate change and sustainability which has lead me on to become the director for sustainability at 3D Reid, my interest in Passivhaus, I am trying to find out a lot more about it, probably more on the commercial side as opposed to housing, so I think the lesson there is to be applied on the commercial side and we have a large interest in the office in schools as well

Me – ok I don't know, Paul, you have just recently come back from Austria where you went to visit a lot of Passivhaus developments would you like to say something about that and how you think that is different from your experiences in the UK?

PB – It was a bit of an eye-opener in terms of the diversity of buildings that we saw, I suppose I came at it as an indulgence of quite rich people designing private residence and to the best of my knowledge that is what is going on in Fortune Green with Justin Bere we have been fighting for a school in Swiss Cottage to be Passivhaus so I was certainly aware that it was theoretically practical to have a Passivhaus school, but what in the course of three very crowded days, Monday, Tuesday, Wednesday this week I saw everything from a catholic church/community centre, solar city outside Linz and a new trophy tower block for the energy company in Linz, a wonderful kindergarten school in Innsbruck about three social housing

projects, a hot-dog stand which was rather charming and so it was an eye-opener, I guess what I came away with was a sense that Austrians tend to use the term as a very attractive futuristic word that they rather abuse and of all the buildings, and we probably saw about 15 in the time, I think I only saw one actual certificate so to the industry they seem to regard the definition of Passivhaus as something that is extremely energy efficient and manages heating, I don't know what the technical term is, but to get below 15 kilowatts per square metre and I guess that everything that we were shown achieved that, I was pretty impressed with the SME industry there, obviously the Austrians, Force Major got into this a lot earlier than anybody else but it is wonderful to see that they actually have a rich team of SMEs, family owned businesses with 25 – 200 employees, no huge players apparently, and a genuine sense of co-operation between those people, we saw a social rented block of about 400 homes in Innsbruck that was only just opening, we asked the site manager, what was his biggest problem, I was surprised and I guess, slightly alarmed when he said finding the skilled craftsmen with the right mentality to actually seal the buildings, because if they have got that problem in Innsbruck, I don't know where we begin because I know we haven't got the craft ability, when in Camden we converted the house in St Augustin's road it was quite apparent that the artisans working on that building did not, initially anyway, get their heads round the problem, so I thought that the Austrians have year after year incentivised the construction to high energy standards and put subsidies in and they have encouraged and nurtured these SMEs to be co-operative and I am very envious that we don't have that body of expert companies in this country, to the best of my knowledge we don't even have a company that is marketing triple glazing which I find astonishing

Me – I mean, do you have any comments on that? Liz maybe?

LR – Possibility Essex, which is on site in Essex has just achieved 0.346 on its first air-tightness test, so that was a builder, building company, that has not been especially trained but they were willing to listen and to apply their brains to delivering what was asked of them and how splendid that they have done it, so it isn't without hope

SB – In the green building, the first Passivhaus that has been certified, as I understand, the one that they have been building in Wales, that was a local builder, cos I tried to look the builder up on the internet and he didn't even have a website as far as I could tell and they achieved 0.25 or

LR – something very low

SB – and you wonder, if they can achieve that, and it is a small building and the way building regulations air-tests are calculations work, it is more difficult on a small building than it is on

a big building so why can't our contractors achieve better than what they are clearly achieving? And designers for that matter?

LR – but what I, I mean John Williamson who is the architect builder there – he is very quietly spoken, and I wonder whether that had a big impact that he just explained what he wanted and told them what to do and said look, if you puncture this air-tightness membrane, please just put your hand up because if we don't achieve what we have set out to do we will have to do it all over again and that he said, was more or less the sum total of what the training was, I mean he must have been showing them what to do but there were no special incentive payments or anything,

BC – but that is what is particular about Jon and what is particular about his process, cos I know him quite well and we worked together as builders as well and when he was starting to get interested in, I am sort of talking for Jon, but we were working on a building with the Centre for Alternative Technology builders and he was taking meticulous notes on everything even then in the way that we were doing it there and his approach is so specific, I mean something similar to Justin's I guess, in that absolute nit-picking level of detail, and I think that you need somebody like that who is very very aware of the processes who can then translate it very easily to other people, the other thing I was going to say about building materials is what I just heard from Bea Rowen from Amazonnails last month when she was doing some teaching with us is that they were achieving better than Passivhaus air-tightness levels with straw bale construction, so I think that getting hung up on specific types of materials is, I'm not promoting straw bales over and above anything else it's just that it can be done with all kinds of materials because it is down to the level of detail and the approach so, but that is a challenge when people are just used to shoving in boards of polystyrene into holes that don't fit them and leaving gaps – and the crisp packets and the fag-ends well whatever, but that is quality control what we are really talking about is quality control,

Me – Lynne, you were going to say something

LS – I was going to contrast that experience with two years ago I was working, I was the director of one of the big firms of architects and I was designing a new and we were building a new community in Dartford and at the same time was chairing a committee for the Scottish Government which delivered the low carbon building standard for Scotland report and we had evidence and so I was kind of, this duality was forced upon me really because we had the national, I think it is the building standards director for Austria, Rainer Zimmermann, I don't know if you have come across him, and he gave a wonderful introduction for the committee to Passivhaus and he emphasised the fact that it was a voluntary standard and somebody, some bright spark had this idea of having a very leading edge standard for

energy efficiency and it was taken up in the private market and he was really sounding a note of caution because he was saying that it has been developed as a voluntary standard and it has been and it does require as we know a great deal of quality control and it does require a very high standard of building fabric components and cos we were considering its influence on potential strategies for Scotland and we just felt that it was a bridge too far and the same time as working on this community in Dartford and each phase we were going from Ecohomes very good to Code Level three and ultimately to Code Level six and I did give a talk at a conference, I shan't name it but it was one of the big house builders and um I was, we were basically on the threshold of what was achievable with our current build technologies and I flagged it up to them that at that time looking forward to an advance standard, they would either have to invest heavily in renewable energy or localised heat, or they would have to go to a much improved fabric standard like Passivhaus and there were two construction directors from the big house builders and they just stood up and said we can't do that, because it is such an alien culture to them, that is not the way they procure and they know that currently the way they procure that standards can only go so far and I think your description of this Jon character is in sharp contrast to the mainstream practice in this country that is our sort of dilemma

CO – I think it is also that we or most people think we know the benefits of getting it right, some people just look at the cost, some people it's all about comfort in the end for all of us and that is not often enough thought through and the other day, I went to Germany and I actually stayed in a Passivhaus and they have a Passivhaus including a basement and I went down there and it was so fascinating, no cold feet nothing, children were playing in the basement it is just that you have so much more space it's fantastic

JH – I think there were several points that are very interesting and I think most of us have or will have put on our sheet, lack of building expertise but it kind of suggests that the British are genetically incapable of building quality houses which is just not true we have just never needed to cos we've had a government that has never regulated strongly enough and we have had north sea oil which meant we didn't have to go down the route that the central Europeans have had to go down for the last thirty years so um Jon can do it, these other examples you have said, they can do it, it's just about being progressive in mind any builder who can see what way the wind is blowing and understands that we have got to do or that we are regulated to do zero carbon by 2016 is going to see Passivhaus as a way forward because otherwise they are not going to have a clue, this is a mandated way of doing things and they'll get that in the end but the more examples we have started then the quicker they'll learn as well

SB – I think that a number of builders are certainly very interested in Passivhaus and as soon as we talk about the cost and we can't do it, I can remember when contractors suddenly throw silly cost premiums onto things when you try and reduce things below the normal ten cubic metres and its ignorance more than anything or quantity surveyors saying these things and it's going to cost you money when it isn't necessarily any more difficult well you have to be thoughtful, you have to just know what you are doing and keep checking it, well I've had, speaking to somebody who has worked, works for one of the major contractors who are very keenly interested in Passivhaus and from his visits over to Germany, his view is that there is a need for a cultural change in the British construction industry and it is part of the procurement process and that has to change and the mentality of that has to change and that comes back to an attitude of we have to get it right it is going to become more prominent and it is not going to cost us more and it is not just about getting there and doing the work for the cheapest possible price necessarily disappearing and I think that that is a mentality that is prevalent within and it is prevalent within the way a lot of buildings are procured right through to government

LR – I mean the fact is the house building industry has got a way for years with delivering rubbish products and people don't even know what a good product is they don't know what they can expect of a well-built home so I am fortunate in that I did procure myself a low energy home in 1992 and again we got down to an air-tightness of two and a half it was before Passivhaus had actually even been invented and people would come in and say God your house is so comfortable, I mean everywhere I go the temperature is even and they can't quite believe it no its just such a different experience

BC – yeah it is what sort of standards we set ourselves, so we are prepared to accept pretty rubbish buildings and we don't expect anything better than that. There is something, there is something about the skills training which is very interesting if you look at how the construction industry skills itself you know what sort of routes people come through as builders and how people get trained and what kind of training they can expect to receive as well and where they want to position themselves in the market as jobbing builders as labourers as brickies or as whatever then I think that is a question for you know all organisations like construction skills council and so on – what are they doing about skilling up the construction industry for the new low carbon era you know we are all supposed to be entering together, I mean this isn't going to be any different from any other part of the mainstream society I think over the next five years, hopefully in the next five years, I know it is a big ask but it's got to be people like the construction skills council and so on and the Green Building Council that support it and government political will to push it and the right tax incentives, maybe things on training and you know getting yourself into low carbon, I

think that is all sort of beginning to happen anyway not to be too negative about it because like you are saying a lot of house builders and people are looking, their heads are starting to turn in this direction it is just from the skills training point of view, what sort of encouragement can happen as far as is possible

LR – I have just come from a meeting with the QCDA the Qualifications and Curriculum Development Authority and we are now starting to develop a series of units that are all about how to deliver low energy buildings and we will be working with one of their consultants to helps us develop our existing materials into the appropriate framework and all of that has had to be approved by construction skills cos the sector skills council have to approve all our new units and so we are working closely with construction skills and hope to develop the core content as it's a bit like what Stuart was saying, people actually don't know what they don't know and that has really been the issue so that construction skills has gradually been grappling with the notion that there is something out there that they really haven't understood and they have to do something about it and they are not even clear about what that might be but at least that they know they don't know it which is progress

LS – it is unfortunate that we had a kind of a bit of a false trail going into MMC at one point because that became a sort of panacea for quality in construction and actually especially when you consider the application of Passivhaus and other low energy standards to our existing standards I mean you just can't do that in the factory we do need to up skill so I think that was a bit of an unfortunate sort of side-track really

LR – good point, I would mention two things on quality one was when I went to a major house builder when they were thinking of us helping them and it was this procurement process and he kind of looked at me and said well I don't think we could do what you are asking and he got out their house types and like this is the book of the house type right and then the manufacturer comes along and says hey look we could supply this and it does brilliant things and they go oh right we could oh we could maybe fit it in there and they don't re-design the house type to take account of new technologies they kind of just bolt things together that don't make sense so and you know I was going to also mention Kingerlee who went to Germany and took all their site supervisors and came back and said well I watch a team of six guys in Germany in three weeks put up an entire shell and I come back and we are on site and I have got 32 trades and they all come in their own white van they all sit and eat their lunch in their own white van they don't even talk to each other let alone act as a team where do I start?

JH – I think that is a really interesting point, having done a bit of house building when I was a carpenter younger man you tended to see so much piece work and you'd go in and it's how

many doors can you do in a day and they pay by how many doors you could do in a day and then a few people would be sub-contracted back into the main contractor to go and fix the 95% of doors that shrunk or weren't fitted properly or the furniture didn't work and the whole thing was seen as a saving cost but the main contractor can't have been making any money because we were having to replace so many doors and bits of architrade and windows and so on and so forth because they were so badly done on piece work they were still paying us the same day rate they would have paid us in the first place to do the job properly and the amount of times you see an electrician go in and take a bit of plaster board off a wall, pull out all the insulation, put wire in, put the plaster board back, the insulations on the floor, I think there is the procurement thing and the whole contractual side of things that needs to be looked at and if it is found that somebody has just done something completely wrong then they should pay for the repair on that and I know that that is a bit harsh on some people but um the regulations need to be put in place and support needs to go in place beside them its rights and responsibilities you have got a responsibility to do something to this level and this is the support we are going to give you and whether that is tool box talks or NVQs in sustainable construction and air-tight building whatever that is it needs to be put in place at the same time at the moment I think the regulations is probably frightening a lot of builders and they are not seeing the support from people like the CSC and the CITB it is just not there at the minute even the federation of master builders recognises a huge skills gap, we've got money to deal with it and don't know what to do with it and when you phone them up and say I'll help you they don't phone back it's just shocking

LR – so you say they have got money to help

JH – yeah

LR – where is it?

JH – the FMB education budget is huge

LR – is it really?

JH – and they are just not spending it

LS – That's interesting

JH- yeah well if you want to talk about it later we will try and see if we can unlock it

LS – I just think we really suffer from the fact that we haven't really had a standard like Passivhaus that certain really useful exemplar buildings could have been populated round so

that ... we don't really have a body of work that has kind of worked through the issues like Passivhaus represents in this country

LR – it is part of the problem because you know we have regulation on carbon as opposed to a percentage reduction against something that we never measure anyway and so how do you know how much energy your building's supposed to use and that's what I like about the Passivhaus standard it is an absolute energy standard to me that is a target to me if you have a target that you work towards it

LS – hopefully the new proposal for the energy efficiency standard will improve that and there is now doubt that we now have a regulatory framework where we need to be in that place – there is another issue actually that I would like to raise and that is whenever I talked to major house builders about Passivhaus standards they always equate it with mechanical ventilation in the indoor environment and I do think there is a real knee-jerk reaction to that in this country, I mean you know I am an enthusiast you know, I've worked in Sweden you know and I've been to lots of whole house ventilation MVHR properties and I have done it in re-furb in this country as well, I know how good the air-quality is but there is a public perception of the air-tight box, I heard the head of, oh God, one of the conservation societies speaking at a conference that I was speaking at last week, he referred again to the air-tight box and it's become a sort of hate object

LR – the air-tight box!

LS – well exactly, it is a very emotive terminology but it represents, and however many men I talk to and they say they can't go to bed at night without leaving the window open I mean if I hear that one more time, I am going to Puke!

JH – it's not like that with me!

LS – Well I just don't know, there is this wrong perception that, whole house ventilation does deliver and can deliver fantastically good air quality, much better than we would get in a normally naturally ventilated building and I think that there's a public perception issue that really needs to be

LR – its industry perception, it is not just the public it is in the industry as a whole we did see that during those task group meetings, kind of coming up to the front to make emotional pleas for natural ventilation you know we must have natural ventilation and I said look, I don't feel emotional about it but can you please tell us what indoor air-quality do you get with natural ventilation at 5-10 air-changes per hour? 15 you know, nobody's got an answer to that so what is this shibboleth they have got and then it was all about if people don't change

the filters on an MVHR, who knows what might happen well it's almost they are going to die you know and what happens when you don't change the filters is gradually the fans will slow down cos it all gets a bit clogged up and your indoor air-quality would eventually begin to suffer so ok we have to set up systems whereby first of all the systems are designed so that the filters are easy to change and secondly that people come round and change them for you if need be

LS – well also, having worked on the Welsh Passivhaus, what you should be designing, let's not forget, the basic is to design in this climate for really good natural ventilation but you design so well with such good fabric that actually you don't need extra systems you can just rely on recovered heat and incidental gains for your heating in the winter season and therefore you are using MVHR as your bit of kit the equivalent of people's gas condensing combi-boiler which is actually a much more complicated bit of kit but the two have different sort of maintenance regimes and I always think there is a whole communication exercise that needs to

LR – you know that Bill Bordass makes a big thing about talking about mixed mode, in other words you don't have to run your thing all year – yes you can open the windows so there is a kind of whole cultural memory of big office buildings that were built as totally sealed units with lots of mechanical ventilation that you could sort of hear vibrating through the walls and actually those were horribly inefficient buildings which did use loads and loads of energy and people did feel uncomfortable not being able to open the window but that is not how it has to be

BC – I think these things are related because I think people's confidence because that's what you are really talking about – perception and confidence is also related to the construction industry then people are thinking well I buy the theory but if you are expecting the British building industry to build it, they are really going to do a shoddy job and this is back to the perception of it again, so however good your theory is, you will still get a vibrating box that doesn't ventilate properly and has got poor air-quality so there is another perception there is a whole job to do about how the construction industry improves its own image there is something else though which I think is very important that we haven't touched on yet which is about architecture training and it is all very well, you know this it always comes back to the builders, it's always the builders fault but you know it is very easy because there is this total mis-match in the UK construction industry between skills sets for architects, builders, QSs , engineers and never the twain shall meet sort of thing and everybody is kind of like you know, you couldn't do this job without me and everybody else is going, you couldn't do the job without me but they don't really get together and say

JH – let's get together and do the job together

BC – lets, even with partnering contracts and all the rest of it there is still a massive lack of communication between the industries and architects, I think, have got a huge, not just architects who have become qualified, but the people who are in charge of architecture training, the RIB A, ARB, all sorts of architectural institutions have completely missed a trick and abdicated a responsibility for environmental education in general ok, I would say that, but I don't say that because I teach at CAT, I teach at CAT because I believe that and I think it is such an important thing, how are we going to get our building stock 80% reduced by 2050 unless architects are educated, QSs are educated and engineers are educated about what this actually means it is not just the builders and in fact it is you know a builder will only do what they are allowed to do to some extent they may not do it very well but they will work within the parameters of the specification for the job

JH – don't you think that part of the problem is that most houses are built by big house builders who have never even seen an architect; they are just off the shelf typologies

LS – that is one issue

JH – there are five or six typologies, whereas an architect doesn't actually do much housing really unless its spec

BC – but I agree with Stuart that it is not just about houses it is about the construction industry generally – Passivhaus you can apply to anything and architects hold a massive responsibility for how buildings in our built environment are perceived and what is important about our built environment, it is the look, is it glossy, is it gorgeous, does it do something new and original? You know it does not matter that once the photographers have gone that the panels are falling off buildings and the water features are, it dribbles and who cares about all of that and that people are miserable in these horrible shopping centres it's about well that's my particular bug-bear is that they aren't environmentally aware that they aren't ecologically trained – in Germany you have an ecological engineer, that job doesn't even exist in this country that's about bio- biology and understanding how whole buildings approach

CO – that is about right

BC – exactly

JH – well there is something in the architecture teaching

CO – that is the only way that we can do that, that we can check it

SB – there are two issues there, I will come back on education because I have some views on that as well, I think that it is interesting seeing about the myths well you can't open windows of Passivhaus well that a lot of people throw at you, well I was at one of Henrietta's presentations a few months ago where I was quite staggered by the almost vicious objections to Passivhaus by people who I thought should know better and you know why that is you know comes back to a, they don't believe a thing because of what have you and whether you have the windows open at night and as a man who has his window open at night a lot of times, although maybe I am getting old and I am not having it open as much nowadays, maybe it is just age gets to you, but I think it is actually this, but what I think there is the link about adaptive environments and you know this thing about sealed buildings, in fact if we can provide adaptive types I mean we can have either the Bill Bordass mixed mode approach or, well the thermal envelope approach does widen and you will get evidence if you can have a wider thermal comfort zone and all these issues come into it so I think maybe Passivhaus doesn't actually push itself or hasn't pushed itself far enough on its ability to be a mixed-mode approach and maybe that is sort of a, maybe that is the way it came out of the original ideas and the founding and the original approach of it was there, I mean can it be more robust even than you think it is? Be more robust, be more mixed mode and can we use evidence to support that?

JH – do you think we need a name change, the whole thing is a knee-jerk reaction to a German word being use as a, well you know people like especially builders

SB – do you tend to spell it the German way; I always tend to spell it the German way as opposed to Passive House

LR – it is so confusing, we have had huge rows when people say Passive House school, then all it does is confuse people and the German haus can be translated as building anyway, so I

JH – do you think it is something we need to – it is all part of the communication problem isn't it, if people don't understand you can open the windows we can't talk to them about air changes, we can't talk to them about, to people who go and live in houses about air-changes per hour and indoor air-quality and sort of

LR – well you know you do...

JH – well you can if you want to re-do or do 25 million houses in the next forty years we have got to keep it simpler, we have got to make the language simpler and say yes you an open the windows any time you want, there's the windows, that's fine and it doesn't actually

mean an enormous penalty – I went to an apartment block in Hannover and one of the residents there a Passivhaus block and one of the residents there had their windows open all night even in the middle of Winter and their heating bill was still no higher than what should be than should be the requirement for a Part L house here, I say should be because obviously our Part L houses don't do what they are supposed to do but even then even on the out, on an external corner block on that flat it was still no higher and that was open all night because the rest of the building still does a certain amount of work in keeping those bills low, in keeping the heat demand low and I think we just need to talk to people a bit better because firstly the German word and I know how builders think and I know how people think, they are a bit, we're British, we are cynical about that kind of thing – is that oh ok let's just give it a better name, really give it a better name and say you can open the windows.

LS – there was the UK Green Building Council conference last week, they had a case study from a Canadian developer, showcasing this development, this huge development in Victoria British Columbia and it's called Dock Side Green and he gave this really upbeat presentation on how people had bought into this and how it's gone up in value and he was like a man on a mission – he started describing these wonderful apartments which people who suffered from respiratory problems like asthma were buying into because the air-quality was so good and at the end of his speech I suddenly thought, he hasn't mentioned Passivhaus, but actually the systems he was describing were Passivhaus systems, but he was describing them in such an upbeat way and he had the case studies to prove it and the values and

LR – he had the holistic system he had got the water the water streams running down

LS – It was such a positive presentation of these same ideas

LR – he was so can do, I just want to go back a bit, I don't want to miss this, you know all the work that has been done at Stamford Brook by Malcolm Bell taught us a lot of things and of course we know that Passivhaus standard is all about junctions where everything joins is where you have to take most care and what Malcolm discovered is that everywhere there was a difficult junction to make well the architects hadn't bothered with that they just left it to the blokes on site and actually I found out that that is very common that often the difficult junctions, the architect pretends aren't there

BC – exactly, they don't know how to detail

JH – it is so true – you talk about the detail and the phone is hello, hello is anybody there, ok a bit of four by two and some plasterboard and that is what happens

CO – like at East London University they started now teaching PHPP and they are going to do heat two with their students, so they will be taught how to deal with this and what it actually means a thermal bridge

SB – just coming back on the education side, one of the other things I do, I am sort of a member of the RIBA validation panel so I've been round to a number of schools, not many, a number of schools of architecture when you go and do that every five years and validate the courses and certainly environmental criteria is part of the RIBA criteria it is meant to be there, but in fact it is interesting when you look at what actually happens on the ground and I went to one school where they are certainly quite well known where their environmental expert had written books etc., and I must admit the courses that they were doing there, I was quite, they were ridiculous because they were too big for them really to get their teeth into, but because architecture training, especially at the part two stage and ah, there is a certain course which is very close to where we are sitting at the moment where it is done on modules it's done on sort of units and you can do anything you like within that unit and that unit sets its agenda and it may or may not be particularly environmental concerns and they may touch on it and everybody touches on it but they have no real in depth knowledge of it and it is in fact very much a minority, it is still very much a minority interest I think within architectural education there is a general understanding about it but I think there is no deep knowledge which is why you maybe need to go on a masters course to get a better knowledge of that or the courses need to get a bit more geared up, I think there is a real issue

BC – is that something about the connection between you know legislation and academia? How academia has to really, if you, you know Quantity Surveying you have the responsibility to represent what is happening in the industry to advise clients, they have an actual moral responsibility, it is written into their charter that you have a moral responsibility not just to explain the lowest way you can get your budget but also to enable that building to still have that value in 20 years' time so they have to be aware of where the legislation is going, where political will is going, the direction of that building is going to have to be surviving in the future, however, architects don't seem to have that same kind of moral, lots of architects, I am vastly generalising of course

JH – isn't there a clause in the architects charter that says you must look after the environment it is pretty woolly

BC - there is, it's just so woolly

JH- has no-one picked them up on it

BC – no that is right – all I am trying to say is

SB – oh I am sorry am I speaking over

BC – no no you are

SB – out of turn

BC – no no I completely agree however it is in the charter and I think that what I am saying is that architecture education or architects whichever, I mean there are some good practices and there are some good practices in the UK, even the best practices, you know the sort of ways that environmental concerns are interpreted can be very loose and vague and general, architecture education, most people came out of architecture education into practice quite a while ago, unless they did their training with a part-time job in practice, don't have the most up-to-date understanding and don't apply it in depth and they are just not knowledgeable enough about the detail

JH – it's also whilst we celebrate people putting up white elephants in Dubai, you know these are our trophy architects while we continue to celebrate this then that is not going to change

CO – that is something, I can only speak for Luxembourg and also Austria because I went there to school like if you go to Secondary school, there is one part in secondary school where you can actually do engineer you still do your languages, you still do your math but you can do your architectural engineering and a proper electrical engineering and there is quite a percentage, I don't know how many people go through that school so there is a whole different perception, you have more respect for and understand more these people what the builder actually does there is more a pride for quality instead of quantity and then a lot of these people go further to the architecture or engineer schools so I had a lot of architects who trained with me who came from these schools, I mean I was just so jealous because they had a knowledge, you couldn't achieve it within five years because they had all this background from five years before and they then worked during the summer schools on site

LR – you see, I think in the UK it's all about aesthetics and it's not about how buildings actually perform and it's not even the energy performance it could be sound insulation and how people move through space and somebody was telling me that she is in this new iconic building up at Oxford University where the corridors kind of go to a triangle and it's just really horrible to be in there and you think how does this happen?

LS – It is very interesting actually because the minister for architecture is part of the department of media and sport and it is very much

LR – you know I had no idea there was one

LS – Yeah,

JH – a minister for architecture

LS – and I er think that is the problem actually, architecture should be about a good built environment and actually I don't know whether this new construction advice can steer it a bit but that has created an inherent conflict – let's not get too architectural

LR – let's try and say something different I mean Passivhaus is about building physics and actually I don't think we teach that in this country, I have tried to find a course called Building Physics and I don't think there is one

BC – well that is how the masters in architecture started out at CAT it was a building physics course basically so you are looking at ventilation, lighting, heating all the other things that operate, thermal comfort a very very strong element in that course and I think that that holistic understanding of how buildings work enables people, you can add all sorts of stuff onto it but that is kind of building ecology in a sense, indoor air-quality, you know they are all part and parcel of and you are absolutely right Bath does some interesting stuff on kind of those aspects and you'll find sort of spatterings of it around different architecture courses obviously the majority of our architecture schools are still based on the modernist ethic of what does something look like, even if the aesthetic has changed the underlying principle of that is – so building physics

Me – what about the input of engineers? Have we got any comments about that?

LR – well I think that that is depressing because engineers you would expect to do better but they don't, I will set you a little quiz question, I don't think any of you here were at the same meeting I was at so the wonderful emirates stadium when it is empty, when there is no match on, nothing is happening, what's its electricity demand

BC – I think depressing

LR – 2 megawatts, 2 megawatts and when there is a match on and everything is happening?

JH – 2 megawatts

LR – 4 megawatts, not that much more

JH – what was that for?

LR – well we can only assume that they leave ventilation systems on all around the place, maybe they heat the pitch who knows all the time

SB – well if it is in the winter they probably will be heating the pitch they will have heating on the pitch

LR – but I mean isn't that incredible that there can be

LS – I mean don't knock the Arsenal

LR – yes I know

BC – I don't want to mix football and architecture

LR – my son said to me oh you are going to have to stop being a fan then mum

JH – I would like to know what the energy usage is if you take the under-floor heating out of the equation

LR – well I don't know whether it is under-floor heating or what it is

JH - I am just telling you that if you take it out then what does that come down to because there is no point having a football stadium if it is going to be frozen.

LR – well I'm sure that things were done when

LS – Well there must be other ways of doing it?

JH – well it is obviously not that well engineered but that is another thing about the Passivhaus and low energy building, people are saying why should I live in a house where everything has got to be very low energy and this that and the other and I look at this city and there is millions of lights on

LR – you have got a fair point

JH – well there is a huge cultural shift that needs to take place because it not just about the communication that we make with clients or builders or architects its everybody really

CO – People think that something that is valid has to cost a lot and there is an investment culture in this country that whatever you do you have to make it look amazing, whatever the quality, whatever the, it just needs to look nice for this particular moment and after that

LS – yeah I was at the Danish Embassy the other week about forth-coming Copenhagen or imminent Copenhagen and it is really interesting because they were saying that in the seventies the Danes decided to artificially inflate energy prices to actually stimulate the market for energy efficiency at the same time we were flogging off our utilities for the free market which has actually caused all sorts of issues because we can't really control any of them – we can't use that mechanism to stimulate

JH – I think that'll change, I think we will have to re-nationalise utilities in the next twenty years

LR – well it might be before that, I think and you need vertical integration because otherwise they don't trade off the cost of generating an additional unit of power to saving an additional unit of power

Me – Paul I was wondering if you had something to say

PB – I can't get a word in

LR – sorry

PB – I am sure it is your normal modus opperandi – I would like – well, I have heard Jason say about antipode to it being a German word and that we need a cultural shift and one of the things that as virtually the layman here that it strikes me that the English myth is that the window is a sort of open chimney on all your heat loss whereas one thing that I really liked about the buildings that I was in was in this week was enormous use of the glass, I think as a city dweller it seems to me that one ideal way of selling the concept is on air-quality and perception actually I think one could move towards a view of sort of children playing in a London Council Estate and the mum yelling at them come in doors because the air is better, that's not as daft as it sounds, the air-quality in this part of the world, the Euston Road, the Finchley road the Theobalds road is absolutely dreadful, I visited a retro-fit industrial warehouse where the managing director showed us the filters and I am sure that this was in a relatively clean part of Austria and the filters when they are dirty are quite scary , it is quite a good way to convince people of what it is they are breathing in, so I would like to see Passivhaus being sold on the back of air-quality and the improvement of life, I don't know if you are aware but the statistics at the moment oh well it doesn't really matter are that the average English person is losing seven months of their life, but buried within that is that if they are losing seven months on 60 million people then what is that saying for the people who live along or work along the Euston road because I believe it is nearer ten years and the

linkage between nitrogen dioxide and carbon sorry cardiovascular disease is becoming a huge matter for concern

CO – when you do Passivhaus you say that you need to change the filters once a year, for the heating season, Justin Bere, every month

LR – really

CO – yeah, every month

LR – oh you mean for inner London

CO – so we hoover it once a month, the second month they need to be exchanged

LR – wow

CO – yeah so bad – so that is all the more reason to really do Passivhaus

JH – so how do you go about managing private houses in the future?

CO – so that is also, we were discussing about that the other day in Germany in the course they say well you need to really discuss that with your client at the beginning the first six months you might do it with them – you can't do it once with them because the second time they might forget and not know again how to do it so we really need to get involved there it is about a good relationship there

JH – so if the house is sold on to a new person

CO – do you need to sell – you would need to write that down in the contract so there is a proper responsibility, who is doing that and there can't be any delay because if we don't get it right at the beginning how shall we do it in five years

SB – yes if you buy a car, which costs a lot less than your house, if you buy a second hand car you expect to get the log book the service book so you should know something about it although you could not possibly repair it unless you are a mechanic – that is a matter of course isn't it and we all look and houses like this

LR – we would ask how many miles to the gallon but we don't ask how much a house is going to user per square meter in a year

BC – apparently people take months to decide which car to buy and make a decision as soon as they enter the door which house they are going to get

SB – well that is true

BC – but for thousands

SB – but it has been such a struggle even to bring in the home information packs which was probably not going to work very well anyway and the Tories are now saying they are going to get rid of them if they win the next election and even that small step of giving people information about the houses has seemed to have hit this incredible buffer

JH – it is generally not very useful information is it ...there are lots of flaws in the system

BC – I think that what is more interesting is what you are talking about with the after sales service with architects in other countries and that is something that is very very common in Germany and other places that we don't expect that, we have something where an architect where the architect is hoping the phone's not going to ring and the phone rings and there is a problem but that's it otherwise it is not our problem its there's the keys, I'll see you in a month's time, I'll be back six months after that as well and the whole after sales service, I mean with a ship when it is launched it goes on a maiden voyage with just its crew to test it out and you can't get your certificate without it for your marine test so what are we doing with our buildings that is so poor we just have this kind of terrible fear and I'm sorry to come back to architects and not engineers we should talk about engineers as well but there is a lack of knowledge and understanding of construction from architects and they cannot wait to get off site very often, they go to a site meeting and they sit there and say oh God this is going to be awful and two hours later they come out saying ok we have got a huge problem that I have caused do you know whatever a snagging list as long as my arm and we're not going to get paid and how am I going to tell practice that actually I've just lost them another ten grand on the price because you know and then you start fighting the contractor in court about who is responsible and ... nightmare, nightmare – you know architects are just persona non grata very often and ... because they don't really understand how buildings are put together let alone the management of people and teams which they very often have to do

Me – Stuart or Lynne, I was going to say

BC – ok that is my very biased opinion

JH – how does certification work in countries where Passivhaus uptake has been longer, cos here if you, I don't assume that local authorities do air-pressure testing or thermographic imagery, it is all private consultancies which adds to the costs which is why, one reason why developers, builders etc. are so against anything like improvements so how does it work in Germany or Austria or anywhere like that, is it under local authority guys, is there any way that we can make the pill less bitter for builders and developers

Me – I am going to have to stop you here and leave that as a kind of rhetorical

JH – can you answer it?

Me – no I can't unfortunately

CO – can I just add something? We have not been using thermal imaging cameras it is far too expensive

JH - I disagree

Me – I just need to go around you all – we can do a little bit more after, could I just ask each of you quickly, have we got enough tape to say what could you say succinctly are the main issues to do with the uptake of Passivhaus design in the UK? Paul

PB – absence of craft in the building trade

Me – Lynne

LS – Absence of demonstration projects that set, where you can go and experience how wonderful it is

LR – Ignorance

Me – C?

CO – people are afraid to take it on because quality control is just up in the air

Me – J?

JH – It is getting harder as you go down the line here, lack of integration within the building industry from architects downwards

BC – damn that was my point, for the trades to talk to each other

Me – and S?

SB – and in addition to that I think some kind of cost base so that you can actually understand what are the costs involved and moving towards standards, whether you go the whole way or part of the way etc. so you actually understand some real costs which just lacks

Me – ok thank you very much we are going to have to stop here....

Transcription Ecobuild Discussion – 02.03.10

HL - Ok, I don't know what people thought about that film, I am sorry it has been a bit quiet, but are there any initial responses to anything that was tabled? CW from WD –

CW– Hello my name is CW from WD and Modcell, you are sitting in a building that will deliver Passivhaus, that is my advert – um, I think it is just all rather depressing, Passivhaus isn't rocket science, we have just got good at doing it really badly and it is sad to hear the architect saying well I didn't and it's a shame that we don't and then the builder saying it is a shame that people do this, Passivhaus is easy to do if you have got everybody trying to do the same job, my only concern with Passivhaus having lived in central Europe is the central European specification for heat recovery, when you slide Passivhaus up to the UK, I start to worry about the boundaries of ventilation against how much carbon spent ventilating unless it is all entirely renewable and we can wait a long time before that happens – that we should be making sure that we apply a central European specification into a temperate climate with adjustments because you can actually tip over to carbon emissions unintentionally when you are ventilating, the other issue is, we have recently done a heat recovery ventilation system and I won't name where but in an acoustically sensitive environment where it had to be switched off very quickly because we are not used to specifying this sort of technology in the UK, in Germany as was described and in Austria, people will spend six years at college learning how to do this, I am slightly worried that we might be bringing in people who say we can do that for you and we will live in very badly ventilated properties so it's not hard, there might be some implementation issues that we have to go through here and then air-tightness is just a habit that we have got to get into rather than exasperate ourselves by saying why can't we build air-tight.

HL – any responses to that? I think there were some issues brought up there relating to what was said in the film about skills deficit in our industry particularly in relation to installation of MVHR

NC– I'm NC from Allford, Hall , Monaghan and Morris, it is maybe lack of skills but lack of ambition so much of what we do is driven by client demands which are driven by cost in the same way the supply chain might be lousy or the skills on site might be poor and that just escalates the costs through the roof so the costs is the big driver, if people came to us and said could we design a building as cheaply or cheaper, then it would be easy to do but the financial aspect of it which genuinely does scare people with Passivhaus it needs to be addressed in a very serious way I think

JS– Hi I am JS and I am a sustainability consultant for JS Associates – one of the things that I am really interested in is this notion of culture in all of this because it seems to me that not only is there enormous kind of technological challenges or not so enormous but certainly challenges but also there is something that needs to be addressed in terms of integration, in terms of skills in terms of the perception so um, I would be curious to see how that changes and it would be good if there was some kind of active way of addressing this

TR– Good morning, my name is TR and I'm from TR Architects and I think the thing I was going to say after watching the film was I think there is actually a huge amount of enthusiasm amongst architects for Passivhaus, well I have noted that in Scotland anyway and my practice is certainly very keen we are all busy learning the PHPP software and so on, but I think there is still a fairly big hill to get over in terms of costs and knowledge, education – you know you have to if you take on a project, and you offer to achieve Passivhaus standard you have to – you know you are taking on something quite big

and so you obviously wonder to yourself are you going to make any money on the first one and from then onwards are you going to have a big education process with the builder, but I am sure it will develop in time is just that it's a fairly big hill to get over at the start

CL– I think there is one other dimension which is partly an answer and partly a contradiction is that it has to be lead also from the demand side – I mean for years one of the problems has been you have got building control regulations and then you think there is a lack of aspiration to do better than that and it gets pressured when you turn around to the client and say we have got an ambition for a building over the long term that will perform very well for you but as a starter for ten, the building regulations are sort of you are going to have to put that to one side and look beyond that and look a lot further and be more ambitious than the regulations than the building regulations start you off at and that becomes very difficult to justify – and everything else you are talking about, there are other kinds of technological offerings, Passivhaus is really interesting and it's exciting and it's been around for a long time and been proven to work but until the client, until it becomes possible for clients to really be convinced and get them get them convinced with enough examples it becomes difficult like other kinds of alternative technologies that do better than the building regs

JH– there is an inherent problem in that they are only going to demand it when their fuel bills go up so high therefore you need some pioneers to actually make it aspirational

RC– I just wanted to counter C's comments about the quality of the ventilation that you get from a heat recovery system in a Passivhaus, I think the Passivhaus concept needs to be sold to clients on the basis of the quality of the indoor environment that it produces primarily and secondly on the basis of the very low energy bills and so on and I think a lot of clients will be more impressed with the quality of the Passivhaus and the quality of the indoor environment which if it's done well you shouldn't get acoustic or ventilation problems in fact the ventilation will be a lot better than it will be in a building regs air-tight conventional house

CW – in response to your response, I have no problem with the quality of air that Passivhaus heat recovery will deliver, what I am concerned about is the UK's ventilation business and their ability to deliver the quality that we know can be achieved and there are a lot of plumbers going around with white vans with banners on the side saying 'renewable energy are us' and I still don't know many plumbers who can install a gas-condensing boiler and know what they are doing so there is a gap there and I am very concerned that we might roll off a couple of Passiv schemes that fall over and we are really good at knocking down tall poppies in the UK, so I just want to make sure we are doing it right and with engineers like this we can but there is a bit of a rush, there is a bit of a gold rush and you know Passivhaus is only an energy spec it is not the cure for everything we face and it is about energy and carbon so there are other things we have got to get right in the house with good ventilation we can do good air-tightness so we don't get mould, with bad ventilation and very high air-tightness, we will get other health and wellbeing issues starting to rise and especially if people switch it off which – how many people go to a hotel room and switch off their air-conditioning at night? – I do that habitually so we have got to make sure that people can live with this kind of technology so I think it is going to be a bumpy road to Passivhaus

JH – I think the idea of the first few falling down probably isn't going to happen because the architects that have been doing them and the building teams so far have really been going at it with the sort of soft landings approach and really follow it up and make sure that everything is working

before they are occupied, I know John Williamson with his office in Wales is in there every day he's playing with things, he is testing them, he gets groups of people in to make sure that flow rates work and I know that Justin and the rest of the guys at Bere architects are working really hard to make sure that they meet all the requirements and do it properly and for architects going out on a limb to do this their reputation hinges on this so I don't think they are just going to be gold rushing really

HL – there have been a lot of issues brought up about air quality, I know that we are not necessarily used to using MVHR particularly in the domestic environment in the UK and some people are worried about the use of MVHR for indoor air-quality and health reasons – there have been issues about it being turned off and causing damp or ... has anybody got any thoughts about that, MVHR or natural ventilation in relation to Passivhaus design?

NC – we are finding clients and even agents wanting to naturally vent Passivhaus proposals and suggesting that they can be run in a kind of mixed-mode way and I think a point about MVHR being a default option in this country and it being relied upon to save energy throughout the year isn't necessarily always right and I do think we need to move on and talk about naturally ventilating Passivhaus buildings which they can be naturally ventilated for much of the time it is only in the peak seasons that they need to be so quietly sealed up it is something that is not widely appreciated that they are not so totally sealed boxes

RC – the thing is that if a house is air-tight it doesn't mean it doesn't have openable windows so you have always got the option to open the windows, but you don't want to expect the occupants to go around and open the windows as their ventilation strategy so it is much more robust to have an MVHR system ticking away in the background and the option to open the windows as a purge when you need it or when you want it, I think that one of the keys for making this all sustainable is designing the building sufficiently low energy so that you don't need a heating system then if you open the windows you have got a choice of being cold or if you shut the window and you save energy and you recover your warmth, so if you open the window and let the heating come on, you have lost the plot

HL – any comments about the management of a Passivhaus at all? What is different from having a Passivhaus design to what we are used to at the moment? Robert was just suggesting that we need to do Passivhaus completely without heating systems?

TR – I was just going to say that a problem that I have when I was just trying to persuade clients to build an ecological house is that a lot of my clients seem to want Agas and open fires and you just can't really do that with a Passivhaus

CW – there is an issue if you have got kids, and they are out in the rain, they don't dry out as quickly as they might in a Passivhaus, so often what you will see in Germany is one radiator in the entrance to the house so that dogs and small children can be aired, so there are practical issues with having a zero-heat home which even in Germany they accept that they might need some kind of radiant heat to deal with those sorts of things

JH – I think it is a psychological issue as much as anything else as well as kind of airing your children it is very psychological – they idea that somebody would like to move into a house where there is no recognised heating system in any way, people would baulk at that and so the houses that I have seen

in Germany as well have got tiny, tiny radiators in the bedroom that you can put a pair of wet socks on and your shoes under and you know it is a psychological issue – at least you can see something there and I think that is entirely right, I think it would be very difficult to fit an unheated house, even to have it there makes the occupants feel a bit happier

CW – I see this as no different from the gasification of the UK housing stock 40 years ago, I can remember, I am old enough to remember my grandmother being horrified of the idea that somebody was going to pump gas, natural or otherwise into her house and then set it alight in order to heat her house, so it is what goes around comes around it is the same problems, we are just not used to change and it will be interesting to see where we will be in about 10 years' time looking back at this discussion

HL – I know that there are a lot of Passivhauses in the second or third phase of Passivhaus in mainland Europe and they do design with top-up space heating of different forms whether it be through like a radiator and gas or different fuel supply one I saw recently was using a biomass boiler in the basement and then there are other people using electric heating, just plugging in electric fires at certain points – but maybe if we are going back to the energy issue – if we are going to start plugging loads of electrical devices over and above what is originally specified any thoughts about that?

RC – I would say that as a long term strategy that makes sense because the electricity is going to become lower carbon particularly if they start bringing out very small heat pumps then that all makes sense as well and I do accept that I would allow a few towel rails certainly into the Passivhaus, I think that that's essential but the other thing to say about gas is that gas is actually going to get a lot more carbon intensive when the north sea runs out and we start importing LNG and Russian gas or African gas which will be much more carbon intensive than north sea gas

CW – and of course Passivhaus is a heating based specification of course there's learning based behaviours to live in a Passivhaus and there's changing behaviours so you could have a Passivhaus with a home cinema drawing down a thousand Watts every night of the week if you chose so Passivhaus doesn't capture everything we need to capture in behaviour change and we are partnering with somebody called Passiv-systems Ltd but their job is to work not only on the heat but the electrical consumption and have learning algorithms in the way they control everything in the house, so Passiv is cracking on heat but it won't change the way we behave in terms of how we expend very intense carbon through electricity, I am glad Robert is very optimistic about de-carbonising our grid but that is going to take quite a while to do

HL – I know that Passivhaus has specific requirements for the amount of primary energy it is supposed to use which includes for all the designed electrical input into your house – clearly maybe there are potential reduction in loads through future technological devices and control of those devices which can cut off or interchange at different points is that going to be kind of a house which is too 'officious', too controlled, not person controlled, to officious in its way of managing your life for you?

CW – my response to that is that I think there are companies trying to work out how to do that without it switching off the lights when you don't want it – Passiv-systems they are looking at I-phone proximity as you drive home half an hour away it will switch up the heating rather than just

switching on on a time basis and a lot of us do live to really kind of patterned behaviours, I think that that is a kind of technological soft issue that could sort a lot of those things out – people do get wound up when lights go off when they don't want them to small children in schools cry in dark toilets when that happens to them, so we do need to pick up all of those soft issues of intelligent management

JH – that is an interesting point because although Passivhaus does have an overall energy requirement it is not exactly stringent in terms of what you can draw down from the electric grid it still works out at something like 25-35kWh/m^2 a year depending on how good the grid is and how efficient the grid is – you might find a back-lash at some point, my heating does this, I have less control over my house and suddenly you are telling me I can only put the washing machine on at 2am because that is when the grid can deal with all that kind of thing, it is interesting as to just how far it is going to push us and just how far we can be pushed and whether that comes down to fossil fuel shortages or climate-change or the cost of your bill is gonna, these are things we just don't know at the minute we can sort of guess but they are all to come really

HL – there are also parameters in Passivhaus which say how much heat you are supposed to design for not just the 15kWh/m^2 but the overall heat from both the heating and the electrical design per square meter to inhibit overheating but to also try and keep people within the specified parameters – do you think there is an issue of people understanding those things in the first place? Energy literacy – do people need to learn to become more aware of what energy actually means if they are going to live in a Passivhaus? Are there issues to do with training that go beyond just living in and opening windows or not opening windows or switching things on or off?

JH – how does that happen on the continent?

HL – I don't know

JH – cos that is quite interesting, how did it happen in Germany and Austria? How did that go in those last 30 years cos we have this thing you know, now we have gone from incandescent to compact fluorescents and maybe to LEDs and so on and that is going to change the heat balance inside the house because you are drawing down less energy and there is less heat – there is less electrical gains inside the house so how is that going to affect the whole heating regime in a Passivhaus?

HL – is Passivhaus future proofed?

CW – no I don't think so – the bottom line is we will adapt and your previous comment on the risk on gas supply into the UK – 80% of our gas supplies in 2020 will come from overseas – Russia and the Middle East so we will see brown outs in gas supply in the UK and we will adapt, when people don't get the energy they'll change their behaviour, but until we start turning the tap down ourselves, whether through regulation or carbon tariffing or internalising the true cost of the energy we use, people will continue to spend until they can't afford to do it so I think in the meantime, we work as hard as we can to make it easy to make it fun not boring it is very difficult to sell less in a consumer society so what more are we selling, better air quality, better health and well-being, I think there is a whole set of marketing that needs to go alongside this and not just sort of banging people on the head about their carbon footprint but we coined a phrase when we were in America last week –

America's no-where near this discussion in the round – and our phrase was our job is to make sustainability so sexy it hurts! And that is what we are going to try and do, I am not going to try and lecture people to say you cannot live our carbon intense lifestyle – I just want to make them the choice that is easy that becomes the carbon less intensive lifestyle

XX (unknown participant) – I just had some work done on my house and I would have thought that government regulations would have been the best way for people doing either renovating or building

CW – Government regulations around retro-fitting um, the government is just starting, there are 50 major feasibility studies looking at retro-fitting, we are doing one with the Technology Strategy Board, they are the sponsors for that for 50, for real case studies retro-fitting the whole range – the CLG's estimation for the spend on its retrofit is a trillion pounds by 2050 – so there is a whole pile of legislation going to start coming through and it will drive innovation it will drive the way we think and I think legislation will get us facing the right way and it will take a while for us to learn how to do it, but yes it is quite tough to retrofit existing houses to Passivhaus standards

JH – part of the problem is financing that – that one trillion is quite scary and government's kind of running away from it and another part of it is the new fabric efficiency standard is pretty dismal I think, it doesn't really go very far and yes governments should do it but at the same time government doesn't want to and doesn't want to be seen to be hurting industry and making things hard for them so regulation can do so much but part of it has got to be left to the market and part of it has got to be left to the people and I think the big changes will come when energy prices go up and that is when everybody will dive in to it

XX – simple things like I live in a pre-1930s solid wall house and so there's grants for people who have got cavity walls so if there was a grant for me to help to put the external on that would make a difference or even taking the VAT off or something

JH - that trillion if you look at it as if you pay and you save – that trillion sort of equates to works out at sort of 25-30 billion a year but you do it on a pay as you save basis and put the charge on the house it will start paying for itself within 8 years well in terms of 8 years that is twice the length of a lifetime of parliament and political suicide so the problem is no government is going to take it on to that extent so...and the bankers have got all the money now so

HL – there was some announcements only this morning about support for loans for insulating your existing property – they have just been announced I am not sure what the details are exactly but

JH – they are getting Tesco to pay for it and getting a 25 year loan on your home rather than on your person so you get it paid for and then the house pays it back over 25 years in terms of energy savings and I think that it is an awful idea

RC – I would point out that the cure for solid walls, particularly if external insulation is not practical is far from decided the best way to insulate solid walls on the inside and avoid the problem, so I think there is a lot more work needed to inform the industry how to go ahead with that before we actually plunge in – it is much more likely to see a bumpy ride in that sphere even than the Passivhaus one

HL – anybody think that Passivhaus is really really a bad idea? – Who has actually lived or been into a Passivhaus? 4 – Any thoughts on that?

SJ– The only one I have been in is the one in Wales – the office building and it was a very pleasant experience it felt very comfortable and calming in a way and we got a tour round and we got to see how it function and there's a lot less kit than I thought there would be in the Passivhaus, it was just a very calm sort of feeling walking into it – I have heard some negative feedback from other people who have been in Passivhauses or who have lived in them who have said that it is too quiet that they need that noise from outside, but I think again that it's that psychological thing that we were talking about previously and the psychology of moving to Passivhaus is going to be huge the whole idea, even if it's not Passivhaus even if it's just a better building or using our buildings in a better way our homes is quite a huge step forward that the UK will have to make

HL – I have also been into the first Passivhaus house in Wales and the one of the owners was a bit astounded about how quiet it was actually inside, I have also been into various houses in Germany where one of the tests is that they are delighted to say that you can't hear anything from outside at all and its actually pretty much true but that may be good in certain situations but maybe that is not desirable for certain people

JH – they must be mad then!

RC- you could always open the windows

TR – I was just going to ask a question of the two architects here – it's something I have been mulling over – I was just wondering if they might think that it might actually be easier for the architect to have a bigger role and organise the construction of Passivhauses themselves? In the way architects used to work before the war when the architect was really the person who organised all the separate trades and the whole building process – might that be easier if you became a specialist in Passivhauses to do that rather than the alternative which is making a general contractor do it

CW – well I have put my money where my mouth is – I became frustrated with the process through which designs had to survive – not blaming anybody but there is all sorts of things that can have you drive into the ditch un-intentionally budget cuts, and for me it became about, unless we own the costs we weren't able to design through all of that so I run an architectural practice called White Design that is trying to do all this through that channel and Modcell is our response to saying ok let's start building them ourselves and that's fabulous, when you own the problem it is a very different mind-set as to saying to an architect, please meet this specification because it is you who has to meet it and it is like your experience of making things we've had to do it and we've had to solve all the problems and I think that that has been very empowering as an architect, it has not undermined me as an architect but it has allowed me to extend my knowledge – we have done this, we have stood in muddy fields working out how to build this stuff and dry fields – I think it is also saying for the contracting industry, it is to stop looking at the risk mitigation on their side so I avoid a perceived risk contractually so that we can see the re-adjustment of professions and contracting positively to get well actually we are all trying to do the same thing whereas contractually we are all on either side of a fence lobbing problems over to each other so I would encourage people to kind of roll their sleeves up and have a go it is the best thing to do to get in there and mix with it

JH – I think that potentially there is something quite beautiful about that as well because the time has come for the building industry as a whole to stop acting in its own cellular microcosmic way and – Passivhaus is quite a good example of the way that the architect and the building services person and the builder need to talk to each other pretty much from the outset to get it to work – I think that that is a lesson that the whole UK industry needs to learn anyway in order to give us better buildings for the future which is quite a good thing

HL – do you think we need a breed of designer which is both architect and engineer do we need to rationalise our professions into somebody who is more skilled but maybe less of them?

JH – that is hard isn't it, I mean other countries do do that to a certain extent and there is building services in the architecture or there is structural training in the architecture training – I think you may be trying to put too much on to one person then perhaps

CL – I disagree with that cos I have actually done both and if you do what you are talking about you become equally unpopular in both organisations for all these reasons – how dare you suggest that's our responsibility that's their problem and you sit on the other side of the fence that's their problem – the end user it is going to live with it anyway – why do we not just have it as the problem we solve

JH - isn't that a result of coming from different places and maybe not starting at the beginning together

CW – I ended up in both places because I had a camp or at least half a foot in both

JH – I think that part of that comes from the fact that we separate those responsibilities from the beginning and not everybody is involved from the beginning, the architect generally says here's the building make it work and then everybody else goes over to the builder and says build it and there is something intrinsically wrong with that and that the thing that needs to be solved and once that has happened I don't think we will see as much of that is their responsibility and that this their responsibility business, it becomes a team effort and it becomes a team solution

RC – I agree with this person here that and possibly in response to the speaker that I would at least initially recommend a development in the way architects work where they do take over pretty much the whole design and supervision of the Passivhaus projects, I think we have been talking about integrated design teams for as long as I have been around at least 20, 30 years and I don't think they are going to work for Passivhaus at least on its initial trajectory – one of the things that I would emphasise and I think it has sort of come out a bit – there is a huge amount, a huge learning curve to go up to do Passivhaus well and that is probably best done by the architect rather than relying on other people to do that for them and in some ways I think the architect have been only too pleased to outsource the M+E to other people and loose that responsibility and I think they should be bringing it back in

Project Manager for Wilmott Dixon – I have heard a lot of talk about architects and engineers and M+E engineers and do we need a super person who is going to do all of these skills – what you actually need is a team that is led by a project manager and that could be an architect, an engineer whoever, what you need more importantly than that is somebody to set the ground rules at the beginning to agree what you all want to achieve and work towards it and have somebody that is constantly bringing you back in line and I can use a really old quote – when a plane flies from here to

go to New York it wants to go from here to New York, but it doesn't go in a straight line, throughout the whole journey it is constantly being pulled back in line by the pilot and if you like, that is what you need, you need somebody who is managing but at the very beginning you need to know where you want to get to and that project brief needs to be agreed and if you like, signed up to by everybody who is in the room and that's the only way you are going to get it go, cos you can't take a group of very very intelligent people with different skill bases and unless someone is managing them you are never going to get anywhere, there are always going to be conflicts

HL – are you a project manager

Project Manager – yeah, I work for Wilmott's as well!

CW – all I would say is that somebody needs to own the problem and what we've done is when we are doing natural ventilated buildings is - not all engineers are as good as Robert and we have had to step in and indemnify the performance so it is about owning the problem either collectively and you signing collectively to do that and that is a new contract form, there's lawyer's going to make money out of this one or just to put in a pitch for good education, I teach at the University of the West of England where we have a degree course in architecture and environmental engineering it is four years you can't do it in three and we need triple A intakes to get them through that process because it is very very tough but there are new types of professionals going to have to emerge, project managers who say, I'll own the carbon issue because if you own it you can earn money from it that's the other thing is everybody is shying away from problem, I've viewed it as a means by which our business grows in a recession so I am more than happy to take on the responsibility but I want to work with the very best people I can find to be able to do that and often on very big projects you are working with people you have never met before it is like you are going on a blind date in front of a client so the way in which we put teams together – I think it needs to be better thought out – so it is all very exciting

HL – There seem to be thoughts about sort of training people in different ways or suggestions about NVQs and your course in Wales etc. – how long is it going to take before we get the UK construction industry ready to build these things if at all?

CW – UK PLC 10 years and it will take 10 years to drive through the educational change but in the meantime you have path-finders you have people who are pushing setting the standards and then what the industry does is very good at copying and then we have got to have mechanisms by which we imbed all of that learning so for all of us, the entire UK construction industry, I think is a 10 year programme

HL – would anybody disagree with that? Do you think we can do that?

CW – I just made it up so

JH – we have to crack on with it we can't just go at it piece meal we've got to really put programmes in place to do that cos there aren't enough really – we've got guys now, you can't say don't do it like that, but that's the way I have always done it and everybody in their firm, no, I have always done it that way since 1830 – yeah we are not in 1830 anymore though are we and that is one of the biggest things to try and get over because these guys have made a living for 40 years on their reputation as being good builders but good building isn't the same as it used to be – it is a different ball game now

a different rules a different everything and it's like telling somebody who's family has been a coal miner for 200 years that they are killing the earth it's just the message isn't going to go down too well – so how we do it has got to be done sensitively as well

SJ – I think that one of the main things that I see is in the reluctance of moving to doing something new is mitigating risk so how do we, there's these little innovation projects and there are various things around the country to show that there are little things around the country to show examples of exemplar performance of buildings but everything is still afraid of that risk of doing something new and even if it is taught in universities it is still going to be something that people are afraid of for I think longer than 10 years unless it is really embedded in the culture in the education system in practice in general

CW – my indemnity insurers would probably flip if I told them half of the things we were doing on the risk front now either that is extremely fool-hardy of us or that is why you take insurance out – you have to say well actually we do need to push forward, so often architects will draw back from saying I'm only copying and pasting a specification forward or I am de-risking it – M+E engineers will do a performance specification – thou shalt do it like this and then a man in a white van turns up and says I have never heard of most of what you are talking about now so I think if you own the risk you will make money if that's a simple enough driver for everybody, there's gold in that there carbon problem and those who will take the risks will reap the rewards and drive through and others will follow and we are taking a big flying risk on what we are trying to do here but I know it is right. Please buy one

HL – so where there are carbon cuts there is brass? We are going to have to come to the end of our session unfortunately – we have got about 5 minutes – I don't know if there are any final thoughts from anybody – any final comments that spring to mind about architects and Passivhaus? Where do you think we are really actually going to be in 10 years' time?

CL – hopefully with a lot of higher aspirations all round, not that we don't have high aspirations by actually being here

RC – not since I have been in the room, people haven't been talking about the cost and I suspect that the push towards Passivhaus by government is tempered quite strongly by the cost it would impose on industry and I am not quite sure how we are going to get around that – cos although you save on some of the M+E kit that you don't need it is at the moment quite expensive – I think part of that cost is that we are good at doing it badly we make money out of doing it badly as an industry, it is a nineteenth century industry – in 10 years' time I think we will be going to America and helping them do the same thing because their target for net zero energy is – no legislation to drive that – is 2030 – there are architects and engineers in the room who are just not going to be in business when that happens so I think – this legislative, the drivers we have in the UK are actually going to push us ahead and we are going to become a knowledge transfer economy because the whole of America is kind of betting on they are going to find some widget to generate electricity without carbon and they are laying down billion dollar bets on that at the moment and refusing – apart from California – to deal with demand side and Passivhaus is a demand side solution so I think in 10 years it becomes a big export opportunity to other parts of the world

HL – who is going to pay for the re-training and skills and how?

JH – how – a penny on income tax and another penny for schools and

CW – the Austrians, the Swedes, the Germans have been building to high air-tightness standards which are higher than us since 1976, they are blonde they are beautiful but all they use are hammers and nails like we do they are not geniuses, this is not – we are not stupid we are just not bothered – I don't think we should pay people not to be bothered, I think we should pay them to be bothered and that is about self-education – guys on site, if you give them the right tool talks, motivate them, it doesn't cost any more to build air-tight – there are some issues to do with glazing specs which add cost – but doing it properly should not cost anybody any more money

JH – as we move towards 2016 and any builder who is worth their salt must be looking to the future, must be looking to how they are going to retrain their guys to do this and where they can find these sources of information so I think the door is open in ways it has never been before in terms of training builders to do it and with most professional qualifications the government puts a bit in and the end user puts a bit in or the user of that education puts a bit in and although that hasn't worked fantastically well with some schemes – I think if you say to a builder this is almost going to guarantee you work for 10 years, then they will bite your arm off and say yeah I'll put in a few grand and train

RC – I would love to support Craig's view about doing it properly does not cost any extra and philosophically that may be true, but I think in practice it may cost extra not because it takes longer but because the person doing it is better trained and therefore commands a higher wage

CW – just to counter that one, I think if you can't do it you are out of work in the future – if you are not prepared to, I think there is a market here that will sort some of this out – I think the other thing to say to some of the sponsors of this, the technology strategy board is trying to drive innovation and part of the bid to them is to say how do we engineer innovation in construction at all levels then we have got Wilmott Dixon who are part of the sponsors for this, they have just taken Jonathan Porritt onto their board that is a very high level appointment which if they are not committed to the words that they are committing to – Jonathan will walk in a very high profile way, so I think there are parts of the industry who are already de-coupling from this old way of thinking and trying to find new ways forward so I am an optimist and it is about a new market and doing business and generating wealth in the low carbon economy – if you are not discussing that now, your business is probably missing the opportunities that already exist

JH – the costs will come down as well, we are doing the BSF schools and they are coming in at about £1700 per square metre and Germany and Belgium are doing Passivhaus schools for 1000 Euros a square metre – so there are loads of reasons behind that, supply chain and labour costs etc. and so on but it doesn't have to be that high and with experience and with better supply chains and so on those costs can come down, it won't in the long run cost any more, and you will probably command a premium as energy prices go up you will start to command more of a premium in terms of low energy houses

Wilmott Dixon man – your observation about Germany doing Passivhaus schools at £1000 per square metre, I recently went to some schools, some Passivhaus schools in Frankfurt and although they are £1000 per square metre they are not as robust in the detailing and some of them are already suffering from things that are needing to be replaced so if we are going to go down the route that we Wilmott Dixon believe we should be going down along with Craig and a bunch of the other

guys we are working with, we also want to build in and make sure that they are still robust and will serve the life of the project and your comment really that nobody has really mentioned cost and we have had now a quick discussion about cost, the other thing that people have not really necessarily picked up on – I would suggest – within Passivhaus if you want to get the Passivhaus accreditation you have to make sure that you get certain materials that are Passivhaus approved in certain locations and those aren't as common in this country as they are in Germany which in itself adds to the cost potentially or it adds to the carbon footprint of shipping it to here, so one of the things that is going to happen in the next 10 years that I believe and we believe in Wilmott Dixon is that you are going to see more and more materials in this country that are going to be built or accredited to Passivhaus standards to allow us to assemble them into the wonderful things that we can do just a couple of thoughts back to Craig

CW – hey always get the last one in! – I think there is an issue about the proprietary ownership of some of these standards this is about reducing carbon – I have nothing against the BRE taking ownership of Passivhaus here in the UK but to say there are Passivhaus certified products is probably restricting access to innovation, probably driving costs up rather than down the way we like to do it and Passivhaus as a specification does not mean that you deliver it – I have worked on enough low energy buildings that simply don't deliver what you hope them to deliver – the display energy certificates are revealing that all across the country so I think it is actually a set of guidance that you should be measured on the outcome and not the certification, BREEAM so BREEAM excellent and not so excellent post construction – I am slightly worried about people taking ownership and actually driving costs up when actually what we need to do is innovate and drive costs down

Wilmott Dixon Man – it shouldn't be just about getting the final tick in the box it should be about the whole approach and that is the thing we are finding, but in order to get there one of the things is that a lot of people are hanging their hat on a certificate with Passivhaus and that means you have got to do certain things and that is affecting stuff whereas we are trying to explore other ways of doing it

Project Name						
No.	Item	Canolfan Hydden	Larch House	Denby Dale	St.Jakob's	Klimasolarhaus
1	*Location*	Machynlleth, Wales	Ebbw Vale, Wales	Denby Dale, Yorkshire	Frankfurt	Berlin
2	*Urban/Rural*	Rural - small town	Rural - new town	Rural - small town	Urban - city center	Urban - city center
3	*Client*	Powys County Council	United Welsh Housing Association + WAG	Private	Frankfurter Aufbau AG	Klimasolarhaus Berlin GbR
4	*Size sq.m*	410 sq m	100 sq m	118 sq m	1927 sq m	2130 sq m
5	*Build Cost*	£1537 /sq m	£1700 /sq m	£1194 /sq m	€1100 /sq m	€1475 /sq m
6	*Funding*	PCC + WAG	BGCB + WAG	Private	Private	KfW, GLS Bank + Private
7	*Occupancy type*	Public Community Centre	Social housing tenants	Private owner occupier	Owner through RSL but private owners	Private housing community/association
8	*Design Team*	Local Welsh + AECB	London	Local Yorkshire + AECB	Not local experienced PH designers	Not local experienced PH designers
9	*Contractors*	Local Welsh	Local Welsh	Local Yorkshire	Not local experienced PH contractors	Not local experienced PH contractors
10	*Construction Type*	Timber frame	Timber frame	Cavity wall construction	Mixed construction Concrete frame	Mixed construction Concrete frame
11	*Design Performance*	15kWh sq m + 120 kWh sq m primary energy	13kWh sq m + 83 kWh sq m primary energy	15kWh sq m + 87 kWh sq m primary energy	12.8 kWh sq.m + 15.8 kWh sq. m + Primary Energy 120 kWh. SqM	8kWh sq m + 42 kWh/sq m primary energy
12	*Built Performance*	Better as predicted	No information yet	As predicted	Better as predicted	No information yet
13	*MVHR zones*	Central system	One	One	Individual flats as one zone each - individual MVHR	Central system
14	*Air-permeability tested*	0.249-1@50 pa	0.2-1@50 pa	0.33-1@50 pa	0.33-1@50 pa * each flat tested separately	0.4-1@50 pa
15	*MVHR*	Central system	One central system	One central system	One in each flat	Central system
16	*Additional Systems e.g. renewable energy technologies*	PVs	PVs	Solar thermal	no renewable energy systems	Wood pellet boiler + solar thermal + grey-water recycling
17	*Supply Chain*	key EU imports - such as MVHR and windows	key EU imports such as MVHR and windows	key EU imports such as MVHR and windows	German/EU	German/EU
18	*Other Facilities*	Remote PVs + green roof	N/A	N/A	Bike stores, storage + garden + green roof	Bike store, community garden + meeting space
19	*Occupant Satisfaction*	Good - a degree of learning associated with systems	No current feedback	Good - had to learn to live there	Good - had to learn to live there	Good - had to learn to live there
20	*Key Issues*	Bringing in German and Austrian design components at extra expense - working with existing LA procurements systems and UK procurement structure as a whole - Designing with Parrt F + BREEAM Excellent	Bringing in German and Austrian design components + bringing in German training for compent installations such as windows - designing to CSH 6	Bringing in German and Austrian design components at extra expense - working with existing planning UK systems - CSH/Passivhaus contradictions - Occupants learning to live in house	Occupants learning to live in the development with new types of technologies - some issues with dry indoor air quality and cost of maintenance of MVHR + acoustics	Occupants learning to live in the development with new types of technologies - Central system for so many flats - grey water recycling and wood pellet boiler + communications and skills during design and construction - some issues with acoustic properties of building and that of MVHR installation - Also issues surrounding learning to operate building with central MVHR system

-5	-4	-3	-2	-1	0	1	2	3	4	5
38. We understand building energy performance well in the UK	39. In the UK there is a good communication between construction trades	4. There is a mature supply chain for Passivhaus components in the UK	20. The UK Government only looks to the BRE to develop building standards	22. UK procurement methods work well to deliver Passivhaus design	6. Passivhaus designs are too expensive	33. Passivhaus designs work well with UK building design aesthetics	31. UK construction types are appropriate for Passivhaus designs	29. The use of MVHR improves indoor air-quality	8. Passivhaus is appropriate for the UK climate	35. The UK has a lack of ambition when it comes to building low energy buildings
	11. SAP is a more appropriate for low energy building design than PHPP	18. Passivhaus buildings are restrictive for occupants	17. The materials used to construct Passivhaus designs have very high embodied energy	13. The Code for Sustainable Homes is a better standard than Passivhaus	9. UK construction skills are appropriate to build Passivhaus designs	5. There are financial incentives to build Passivhaus designs in the UK	42. The Passivhaus standard is appropriate for new and refurbishment projects	12. The Passivhaus standard is very flexible	34. People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	
		30. We understand how to detail buildings well in the UK	7. The UK responds well to the Passivhaus German language product	41. UK clients are ready to adopt the Passivhaus standard	37. Passivhaus buildings are difficult to construct	32. There is a market for Passivhaus designs in the UK	43. Passivhaus needs strong and coherent representation in the UK	21. People associate low energy building performance with on-site renewable energy technologies not fabric performance		
		25. UK current legislation favours Passivhaus design	10. UK design skills are appropriate to design Passivhaus buildings	15. The UK has many existing Passivhaus buildings to learn from	1. The Passivhaus Standard is well understood in the UK	2. Passivhaus buildings offer good comfort for occupants	24. Passivhaus buildings have to perform as specified to work	36. Passivhaus designs are future proof		
			16. We understand building fabric performance well in the UK	27. Our planning system supports the Passivhaus standard well	40. There is a good communication between different members of the design team in the UK	19. The Passivhaus standard will only catch on if the major housebuilders adopt it	23. The UK construction industry has a 'fast-buck' mentality			
				26. MVHR uses more energy than it saves	3. Passivhaus components are affordable in the UK	28. PHPP is developed well for UK design scenarios				
					14. The German name Passivhaus is appropriate for the UK market					

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16. We understand building fabric performance well in the UK	30. We understand how to detail buildings well in the UK	11. SAP is a more appropriate for low energy building design than PHPP	4. There is a mature supply chain for Passivhaus components in the UK	40. There is a good communication between different members of the design team in the UK	17. The materials used to construct Passivhaus designs have very high embodied energy	43. Passivhaus needs strong and coherent representation in the UK	20. The UK Government only looks to the BRE to develop building standards	21. People associate low energy building performance with on-site renewable energy technologies not fabric performance	36. Passivhaus designs are future proof	2. Passivhaus buildings offer good comfort for occupants
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		13. The Code for Sustainable Homes is a better standard than Passivhaus	18. Passivhaus buildings are restrictive for occupants	15. The UK has many existing Passivhaus buildings to learn from	39. In the UK there is a good communication between construction trades	14. The German name Passivhaus is appropriate for the UK market	42. The Passivhaus standard is appropriate for new and refurbishment projects	8. Passivhaus is appropriate for the UK climate		
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		16. We understand building fabric performance well in the UK	9. UK construction skills are appropriate to build Passivhaus designs	3. Passivhaus components are affordable in the UK	36. Passivhaus designs are future proof	21. People associate low energy building performance with on-site renewable energy technologies not fabric performance	23. The UK construction industry has a 'fast-buck' mentality	28. PHPP is developed well for UK design scenarios		
			22. UK procurement methods work well to deliver Passivhaus design	4. There is a mature supply chain for Passivhaus components in the UK	13. The Code for Sustainable Homes is a better standard than Passivhaus	6. Passivhaus designs are too expensive	24. Passivhaus buildings have to perform as specified to work			
				15. The UK has many existing Passivhaus buildings to learn from	20. The UK Government only looks to the BRE to develop building standards	12. The Passivhaus standard is very flexible				
					38. We understand building energy performance well in the UK					

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34. People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	27. Our planning system supports the Passivhaus standard well	20. The UK Government only looks to the BRE to develop building standards	22. UK procurement methods work well to deliver Passivhaus design	39. In the UK there is a good communication between construction trades	24. Passivhaus buildings have to perform as specified to work	28. PHPP is developed well for UK design scenarios	32. There is a market for Passivhaus designs in the UK	16. We understand building fabric performance well in the UK	43. Passivhaus needs strong and coherent representation in the UK	23. The UK construction industry has a 'fast-buck' mentality
	25. UK current legislation favours Passivhaus design	1. The Passivhaus Standard is well understood in the UK	3. Passivhaus components are affordable in the UK	15. The UK has many existing Passivhaus buildings to learn from	42. The Passivhaus standard is appropriate for new and refurbishment projects	11. SAP is a more appropriate for low energy building design than PHPP	12. The Passivhaus standard is very flexible	21. People associate low energy building performance with on-site renewable energy technologies not fabric performance	19. The Passivhaus standard will only catch on if the major housebuilders adopt it	
		14. The German name Passivhaus is appropriate for the UK market	4. There is a mature supply chain for Passivhaus components in the UK	5. There are financial incentives to build Passivhaus designs in the UK	17. The materials used to construct Passivhaus designs have very high embodied energy	10. UK design skills are appropriate to design Passivhaus buildings	13. The Code for Sustainable Homes is a better standard than Passivhaus	36. Passivhaus designs are future proof		
		7. The UK responds well to the Passivhaus German language product	9. UK construction skills are appropriate to build Passivhaus designs	33. Passivhaus designs work well with UK building design aesthetics	41. UK clients are ready to adopt the Passivhaus standard	40. There is a good communication between different members of the design team in the UK	8. Passivhaus is appropriate for the UK climate	35. The UK has a lack of ambition when it comes to building low energy buildings		
			31. UK construction types are appropriate for Passivhaus designs	37. Passivhaus buildings are difficult to construct	26. MVHR uses more energy than it saves	30. We understand how to detail buildings well in the UK	2. Passivhaus buildings offer good comfort for occupants			
				6. Passivhaus designs are too expensive	38. We understand building energy performance well in the UK	29. The use of MVHR improves indoor air-quality				
					18. Passivhaus buildings are restrictive for occupants					

-5	-4	-3	-2	-1	0	1	2	3	4	5
27. Our planning system supports the Passivhaus standard well	26. MVHR uses more energy than it saves	13. The Code for Sustainable Homes is a better standard than Passivhaus	22. UK procurement methods work well to deliver Passivhaus design	5. There are financial incentives to build Passivhaus designs in the UK	14. The German name Passivhaus is appropriate for the UK market	40. There is a good communication between different members of the design team in the UK	8. Passivhaus is appropriate for the UK climate	2. Passivhaus buildings offer good comfort for occupants	15. The UK has many existing Passivhaus buildings to learn from	19. The Passivhaus standard will only catch on if the major housebuilders adopt it
	1. The Passivhaus Standard is well understood in the UK	16. We understand building fabric performance well in the UK	10. UK design skills are appropriate to design Passivhaus buildings	3. Passivhaus components are affordable in the UK	11. SAP is a more appropriate for low energy building design than PHPP	36. Passivhaus designs are future proof	32. There is a market for Passivhaus designs in the UK	29. The use of MVHR improves indoor air-quality	35. The UK has a lack of ambition when it comes to building low energy buildings	
		41. UK clients are ready to adopt the Passivhaus standard	37. Passivhaus buildings are difficult to construct	17. The materials used to construct Passivhaus designs have very high embodied energy	28. PHPP is developed well for UK design scenarios	6. Passivhaus designs are too expensive	23. The UK construction industry has a 'fast-buck' mentality	20. The UK Government only looks to the BRE to develop building standards		
		9. UK construction skills are appropriate to build Passivhaus designs	25. UK current legislation favours Passivhaus design	33. Passivhaus designs work well with UK building design aesthetics	39. In the UK there is a good communication between construction trades	12. The Passivhaus standard is very flexible	21. People associate low energy building performance with on-site renewable energy technologies not fabric performance	34. People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs		
			4. There is a mature supply chain for Passivhaus components in the UK	30. We understand how to detail buildings well in the UK	7. The UK responds well to the Passivhaus German language product	24. Passivhaus buildings have to perform as specified to work	42. The Passivhaus standard is appropriate for new and refurbishment projects			
				18. Passivhaus buildings are restrictive for occupants	31. UK construction types are appropriate for Passivhaus designs	43. Passivhaus needs strong and coherent representation in the UK				
					38. We understand building energy performance well in the UK					

-5	-4	-3	-2	-1	0	1	2	3	4	5
9. UK construction skills are appropriate to build Passivhaus designs	15. The UK has many existing Passivhaus buildings to learn from	22. UK procurement methods work well to deliver Passivhaus design	30. We understand how to detail buildings well in the UK	33. Passivhaus designs work well with UK building design aesthetics	24. Passivhaus buildings have to perform as specified to work	6. Passivhaus designs are too expensive	37. Passivhaus buildings are difficult to construct	23. The UK construction industry has a 'fast-buck' mentality	35. The UK has a lack of ambition when it comes to building low energy buildings	36. Passivhaus designs are future proof
	27. Our planning system supports the Passivhaus standard well	16. We understand building fabric performance well in the UK	10. UK design skills are appropriate to design Passivhaus buildings	18. Passivhaus buildings are restrictive for occupants	41. UK clients are ready to adopt the Passivhaus standard	29. The use of MVHR improves indoor air-quality	19. The Passivhaus standard will only catch on if the major housebuilders adopt it		2. Passivhaus buildings offer good comfort for occupants	
		11. SAP is a more appropriate for low energy building design than PHPP	4. There is a mature supply chain for Passivhaus components in the UK	40. There is a good communication between different members of the design team in the UK	20. The UK Government only looks to the BRE to develop building standards	5. There are financial incentives to build Passivhaus designs in the UK	34. People in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs	8. Passivhaus is appropriate for the UK climate		
		17. The materials used to construct Passivhaus designs have very high embodied energy	25. UK current legislation favours Passivhaus design	13. The Code for Sustainable Homes is a better standard than Passivhaus	7. The UK responds well to the Passivhaus German language product	3. Passivhaus components are affordable in the UK	32. There is a market for Passivhaus designs in the UK	43. Passivhaus needs strong and coherent representation in the UK		
			1. The Passivhaus Standard is well understood in the UK	39. In the UK there is a good communication between construction trades	28. PHPP is developed well for UK design scenarios	14. The German name Passivhaus is appropriate for the UK market	12. The Passivhaus standard is very flexible			
				38. We understand building energy performance well in the UK	31. UK construction types are appropriate for Passivhaus designs	42. The Passivhaus standard is appropriate for new and refurbishment projects				
					26. MVHR uses more energy than it saves					

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Correlation Matrix Between Sorts

SORTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1 one	100	45	48	39	37	30	30	41	32	62	46	40	40	41	44	60	37	58	41	36	22	58	44	31	42	21	49	43	40	41
2 two	45	100	30	63	66	76	69	73	69	70	64	57	55	45	64	59	51	45	60	47	22	19	64	64	21	55	61	19	21	41
3 three	48	30	100	18	32	18	50	36	39	30	29	40	35	34	34	36	37	24	37	3	24	22	56	33	12	14	33	25	24	32
4 four	39	63	18	100	55	63	50	72	57	68	65	53	48	45	62	56	65	63	48	68	28	16	50	65	34	51	58	42	32	55
5 five	37	66	32	55	100	69	63	66	62	63	57	51	62	43	62	62	60	27	56	52	24	5	52	67	32	50	69	26	17	49
6 six	30	76	18	63	69	100	67	68	63	65	54	53	61	48	72	49	60	47	49	54	26	6	49	67	21	67	66	30	28	60
7 seven	30	69	50	50	63	67	100	67	60	53	52	58	61	42	71	62	50	42	51	37	21	11	61	57	5	37	52	5	25	46
8 eight	41	73	36	72	66	68	67	100	61	78	69	58	57	52	72	58	68	55	62	58	23	25	51	71	28	55	58	30	33	47
9 nine	32	69	39	57	62	63	60	61	100	51	45	52	45	40	55	30	50	34	47	42	17	13	54	51	29	54	55	23	11	37
10 ten	62	70	30	68	63	65	53	78	51	100	68	61	57	47	64	61	65	69	62	63	23	44	48	71	37	51	58	52	39	58
11 eleven	46	64	29	65	57	54	52	69	45	68	100	55	50	42	56	56	64	46	61	60	38	24	55	63	39	47	53	23	26	41
12 twelve	40	57	40	53	51	53	58	58	52	61	55	100	39	41	48	48	58	41	50	60	16	34	50	72	36	29	47	26	32	55
13 thirteen	40	55	35	48	62	61	61	57	45	57	50	39	100	46	65	66	49	53	60	45	22	15	51	59	26	57	58	39	23	46
14 fourteen	41	45	34	45	43	48	42	52	40	47	42	41	46	100	55	55	53	43	63	45	29	37	44	48	43	50	58	39	32	40
15 fifteen	44	64	34	62	62	72	71	72	55	64	56	48	65	55	100	67	66	59	53	40	43	18	69	55	19	56	57	34	43	51
16 sixteen	60	59	36	56	62	49	62	58	30	61	56	48	66	55	67	100	52	50	51	34	28	31	66	53	21	24	53	34	34	55
17 seventee	37	51	37	65	60	60	50	68	50	65	64	58	49	53	66	52	100	50	60	58	32	29	48	71	39	47	61	54	40	55
18 eighteen	58	45	24	63	27	47	42	55	34	69	46	41	53	43	59	50	50	100	52	52	45	53	33	48	34	47	43	48	58	40
19 nineteen	41	60	37	48	56	49	51	62	47	62	61	50	60	63	53	51	60	52	100	54	42	45	51	63	47	50	61	47	39	37
20 twenty	36	47	3	68	52	54	37	58	42	63	60	60	45	45	40	34	58	52	54	100	18	36	25	60	54	61	54	35	21	44
21 twenty1	22	22	24	28	24	26	21	23	17	23	38	16	22	29	43	28	32	45	42	18	100	4	40	33	26	38	44	29	55	29
22 twenty2	58	19	22	16	5	6	11	25	13	44	24	34	15	37	18	31	29	53	45	36	4	100	21	16	42	5	10	34	24	8
23 twenty3	44	64	56	50	52	49	61	51	54	48	55	50	51	44	69	66	48	33	51	25	40	21	100	47	8	34	48	34	30	37
24 twenty4	31	64	33	65	67	67	57	71	51	71	63	72	59	48	55	53	71	48	63	60	33	16	47	100	26	47	66	36	36	71
25 n	42	21	12	34	32	21	5	28	29	37	39	36	26	43	19	21	39	34	47	54	26	42	8	26	100	37	47	31	27	24
26 twenty6	21	55	14	51	50	67	37	55	54	51	47	29	57	50	56	24	47	47	50	61	38	5	34	47	37	100	58	34	14	31

27	twenty7	49	61	33	58	69	66	52	58	55	58	53	47	58	58	57	53	61	43	61
54	44	10	48	66	47	58	100	46	32	58										
28	twenty8	43	19	25	42	26	30	5	30	23	52	23	26	39	39	34	34	54	48	47
35	29	34	34	36	31	34	46	100	42	47										
29	twenty9	40	21	24	32	17	28	25	33	11	39	26	32	23	32	43	34	40	58	39
21	55	24	30	36	27	14	32	42	100	31										
30	thirty	41	41	32	55	49	60	46	47	37	58	41	55	46	40	51	55	55	40	37
44	29	8	37	71	24	31	58	47	31	100										
31	thirty1	43	55	12	78	60	68	38	62	44	69	56	54	46	44	66	58	73	58	45
59	37	18	48	65	37	48	58	58	42	70										
32	thirty2	38	61	26	73	70	71	50	73	60	71	49	58	55	52	64	51	73	57	55
67	42	18	46	78	38	61	74	57	37	65										
33	thirty3	18	-14	12	11	10	13	-5	2	-1	18	9	24	27	34	8	14	32	25	16
35	23	4	-1	32	29	26	29	48	41	40										
34	thirty4	25	1	6	25	-5	3	-16	11	5	8	15	14	3	39	18	10	32	37	36
14	34	33	22	21	26	7	20	38	44	4										
35	thirty5	36	39	12	52	49	40	28	58	39	57	42	47	29	33	39	28	47	31	53
52	5	30	19	51	53	30	46	28	21	34										
36	thirty6	54	54	34	60	64	55	38	58	37	63	68	49	51	53	54	58	64	55	65
65	53	32	55	60	50	65	67	51	39	44										
37	thirty7	33	55	27	54	63	74	53	56	44	52	59	42	54	53	68	54	59	46	51
37	62	2	56	65	24	48	69	40	43	56										
38	thirty8	35	50	3	71	50	55	39	62	43	69	52	53	42	40	51	41	66	65	56
73	36	39	33	66	30	53	58	49	39	51										
39	thirty9	42	42	24	41	49	62	33	55	28	60	35	42	37	54	51	35	55	44	47
47	38	20	31	56	44	50	64	54	50	57										
40	forty	62	46	39	50	46	47	33	42	29	53	50	51	38	57	54	56	63	57	54
39	46	34	47	57	42	37	55	52	50	57										
41	forty1	45	50	28	67	60	63	39	62	49	69	55	37	47	52	63	49	64	52	49
45	49	13	50	64	37	47	76	59	48	64										
42	forty2	26	36	21	29	42	50	35	42	18	44	29	15	37	34	46	47	37	38	40
9	44	-2	29	49	-8	34	47	39	43	54										
43	forty3	35	58	31	53	67	63	47	44	47	47	44	42	51	49	56	47	54	28	45
45	40	-9	44	60	28	55	65	36	27	63										
44	forty4	55	55	39	55	48	57	43	52	50	58	47	53	48	61	53	61	65	55	46
45	39	39	43	61	35	35	56	39	39	63										

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Correlation Matrix Between Sorts

SORTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
45 forty5	53	68	38	68	64	71	62	58	48	59	51	63	58	55	66	64	61	46	55	54	32	13	63	71	23	50	76	50	44	68

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Correlation Matrix Between Sorts

SORTS	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1 one	43	38	18	25	36	54	33	35	42	62	45	26	35	55	53
2 two	55	61	-14	1	39	54	55	50	42	46	50	36	58	55	68
3 three	12	26	12	6	12	34	27	3	24	39	28	21	31	39	38
4 four	78	73	11	25	52	60	54	71	41	50	67	29	53	55	68
5 five	60	70	10	-5	49	64	63	50	49	46	60	42	67	48	64
6 six	68	71	13	3	40	55	74	55	62	47	63	50	63	57	71
7 seven	38	50	-5	-16	28	38	53	39	33	33	39	35	47	43	62
8 eight	62	73	2	11	58	58	56	62	55	42	62	42	44	52	58
9 nine	44	60	-1	5	39	37	44	43	28	29	49	18	47	50	48
10 ten	69	71	18	8	57	63	52	69	60	53	69	44	47	58	59
11 eleven	56	49	9	15	42	68	59	52	35	50	55	29	44	47	51
12 twelve	54	58	24	14	47	49	42	53	42	51	37	15	42	53	63
13 thirteen	46	55	27	3	29	51	54	42	37	38	47	37	51	48	58
14 fourteen	44	52	34	39	33	53	53	40	54	57	52	34	49	61	55
15 fifteen	66	64	8	18	39	54	68	51	51	54	63	46	56	53	66
16 sixteen	58	51	14	10	28	58	54	41	35	56	49	47	47	61	64
17 seventee	73	73	32	32	47	64	59	66	55	63	64	37	54	65	61
18 eighteen	58	57	25	37	31	55	46	65	44	57	52	38	28	55	46
19 nineteen	45	55	16	36	53	65	51	56	47	54	49	40	45	46	55
20 twenty	59	67	35	14	52	65	37	73	47	39	45	9	45	45	54
21 twenty1	37	42	23	34	5	53	62	36	38	46	49	44	40	39	32
22 twenty2	18	18	4	33	30	32	2	39	20	34	13	-2	-9	39	13
23 twenty3	48	46	-1	22	19	55	56	33	31	47	50	29	44	43	63
24 twenty4	65	78	32	21	51	60	65	66	56	57	64	49	60	61	71
25 n	37	38	29	26	53	50	24	30	44	42	37	-8	28	35	23
26 twenty6	48	61	26	7	30	65	48	53	50	37	47	34	55	35	50
27 twenty7	58	74	29	20	46	67	69	58	64	55	76	47	65	56	76
28 twenty8	58	57	48	38	28	51	40	49	54	52	59	39	36	39	50
29 twenty9	42	37	41	44	21	39	43	39	50	50	48	43	27	39	44
30 thirty	70	65	40	4	34	44	56	51	57	57	64	54	63	63	68
31 thirty1	100	79	24	34	48	65	61	70	59	69	70	44	59	63	70
32 thirty2	79	100	36	22	55	67	66	68	70	61	72	43	61	66	72
33 thirty3	24	36	100	26	18	34	27	24	31	35	26	26	31	29	26
34 thirty4	34	22	26	100	24	29	25	26	20	43	29	13	6	23	24
35 thirty5	48	55	18	24	100	42	35	40	37	30	37	20	34	31	42
36 thirty6	65	67	34	29	42	100	63	65	59	72	60	46	58	50	66
37 thirty7	61	66	27	25	35	63	100	47	58	61	74	61	60	58	64
38 thirty8	70	68	24	26	40	65	47	100	52	48	65	41	46	54	58
39 thirty9	59	70	31	20	37	59	58	52	100	57	69	44	54	50	66
40 forty	69	61	35	43	30	72	61	48	57	100	55	41	48	58	66
41 forty1	70	72	26	29	37	60	74	65	69	55	100	54	55	59	63
42 forty2	44	43	26	13	20	46	61	41	44	41	54	100	57	49	47
43 forty3	59	61	31	6	34	58	60	46	54	48	55	57	100	63	69
44 forty4	63	66	29	23	31	50	58	54	50	58	59	49	63	100	56

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Correlation Matrix Between Sorts

SORTS	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
45 forty5	70	72	26	24	42	66	64	58	66	66	63	47	69	56	100

Unrotated Factor Matrix

	Factors 1	2	3	4	5	6	7
SORTS							
1 one	0.6065	-0.2640	0.0406	-0.0222	0.3918	0.0753	-0.1484
2 two	0.7296	0.4036	0.1162	0.1227	0.2072	0.0286	-0.0753
3 three	0.4151	-0.0763	0.0024	0.2040	0.3818	0.0972	0.1040
4 four	0.7724	0.2777	0.0543	-0.2153	-0.0967	0.0273	-0.1943
5 five	0.7365	0.3431	0.0830	0.1612	-0.0080	0.0155	0.1992
6 six	0.7733	0.3352	0.0793	0.2230	-0.1337	0.0398	-0.0201
7 seven	0.6332	0.4234	0.1283	0.3067	0.3073	0.1005	0.0076
8 eight	0.7902	0.3142	0.0696	-0.0747	0.1434	0.0104	0.0134
9 nine	0.6142	0.3359	0.0793	0.0914	0.1514	0.0150	0.1096
10 ten	0.8281	0.1186	0.0110	-0.2130	0.1263	0.0271	-0.0864
11 eleven	0.7148	0.1560	0.0178	-0.1090	0.1260	0.0110	0.0017
12 twelve	0.6781	0.2030	0.0293	-0.2054	0.1234	0.0252	0.0670
13 thirteen	0.6816	0.1438	0.0152	0.1633	0.1273	0.0223	0.0666
14 fourteen	0.6797	-0.2018	0.0228	0.1010	0.1337	0.0137	0.1633
15 fifteen	0.7849	0.1657	0.0201	0.2089	0.0945	0.0284	-0.1777
16 sixteen	0.7056	0.0236	0.0007	0.1324	0.2696	0.0447	-0.2147
17 seventee	0.8065	0.0212	0.0009	-0.1471	-0.0591	0.0118	0.0495
18 eighteen	0.6947	-0.1905	0.0201	-0.2205	0.0948	0.0255	-0.3033
19 nineteen	0.7503	-0.0772	0.0027	-0.0519	0.2024	0.0189	0.1968
20 twenty	0.6775	0.1665	0.0200	-0.4521	-0.1058	0.1116	0.2625
21 twenty1	0.4776	-0.3823	0.0906	0.2028	-0.1502	0.0377	-0.0274
22 twenty2	0.3311	-0.2784	0.0455	-0.4435	0.5382	0.2706	-0.1189
23 twenty3	0.6445	0.0803	0.0051	0.2718	0.2623	0.0750	-0.1389
24 twenty4	0.8170	0.1964	0.0278	-0.0487	-0.1300	0.0110	0.0705
25 n	0.4620	-0.2326	0.0308	-0.3064	0.0509	0.0455	0.4085
26 twenty6	0.6315	0.0989	0.0075	0.0483	-0.1175	0.0105	0.2649
27 twenty7	0.8065	-0.0022	0.0002	0.1857	-0.1176	0.0289	0.1922

28 twenty8	0.5754	-0.3562	0.0777	-0.1112	-0.1844	0.0250	-0.0664
29 twenty9	0.5110	-0.4467	0.1281	-0.0045	-0.0152	0.0004	-0.1936
30 thirty	0.6959	0.0247	0.0007	0.0812	-0.2061	0.0292	-0.0628
31 thirty1	0.8104	0.0751	0.0049	-0.1502	-0.2919	0.0587	-0.3065
32 thirty2	0.8625	0.0861	0.0064	-0.0380	-0.2448	0.0347	0.0589
33 thirty3	0.3163	-0.3396	0.0701	-0.0705	-0.3307	0.0639	0.2234
34 thirty4	0.2920	-0.5058	0.1699	-0.2409	-0.0278	0.0281	-0.0906
35 thirty5	0.5457	0.0864	0.0058	-0.3529	0.0210	0.0606	0.2184
36 thirty6	0.8128	-0.1329	0.0094	-0.0629	-0.0760	0.0052	0.0960
37 thirty7	0.7678	-0.0359	0.0004	0.3167	-0.1886	0.0787	-0.0523
38 thirty8	0.7367	0.0345	0.0013	-0.2969	-0.2222	0.0718	-0.1016
39 thirty9	0.7014	-0.1762	0.0170	0.0335	-0.2338	0.0325	0.0422
40 forty	0.7424	-0.3247	0.0637	-0.0164	-0.0158	0.0003	-0.0790
41 forty1	0.7949	-0.0971	0.0047	0.1007	-0.2229	0.0354	-0.1185
42 forty2	0.5360	-0.0958	0.0042	0.3242	-0.2387	0.0942	-0.2126
43 forty3	0.6989	0.0770	0.0049	0.3408	-0.2221	0.0960	0.1180
44 forty4	0.7486	-0.0836	0.0032	0.0664	0.0413	0.0034	-0.0866

Unrotated Factor Matrix (continued)

	Factors 1	2	3	4	5	6	7
SORTS							
45 forty5	0.8294	0.0853	0.0062	0.1428	-0.1274	0.0224	-0.0414
Eigenvalues	21.2000	2.4226	0.1351	1.8873	1.8150	0.1779	1.1263
% expl.Var.	47	5	0	4	4	0	3

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Cumulative Communalities Matrix

	Factors 1 Thru						
	1	2	3	4	5	6	7
SORTS							
1 one	0.3679	0.4376	0.4392	0.4397	0.5932	0.5989	0.6209
2 two	0.5323	0.6952	0.7087	0.7237	0.7667	0.7675	0.7732
3 three	0.1723	0.1782	0.1782	0.2198	0.3656	0.3750	0.3858
4 four	0.5967	0.6738	0.6767	0.7231	0.7324	0.7332	0.7709
5 five	0.5424	0.6601	0.6670	0.6930	0.6930	0.6933	0.7330
6 six	0.5980	0.7104	0.7167	0.7664	0.7842	0.7858	0.7862
7 seven	0.4010	0.5802	0.5967	0.6907	0.7851	0.7952	0.7953
8 eight	0.6244	0.7231	0.7280	0.7336	0.7541	0.7542	0.7544
9 nine	0.3773	0.4901	0.4964	0.5047	0.5277	0.5279	0.5399
10 ten	0.6857	0.6998	0.6999	0.7453	0.7612	0.7620	0.7694
11 eleven	0.5110	0.5353	0.5357	0.5475	0.5634	0.5636	0.5636
12 twelve	0.4598	0.5010	0.5019	0.5441	0.5593	0.5599	0.5644
13 thirteen	0.4646	0.4853	0.4855	0.5121	0.5283	0.5288	0.5333
14 fourteen	0.4620	0.5027	0.5033	0.5135	0.5313	0.5315	0.5582
15 fifteen	0.6161	0.6435	0.6439	0.6876	0.6965	0.6973	0.7289
16 sixteen	0.4979	0.4985	0.4985	0.5160	0.5887	0.5907	0.6368
17 seventee	0.6504	0.6508	0.6508	0.6725	0.6760	0.6761	0.6786
18 eighteen	0.4826	0.5189	0.5193	0.5679	0.5769	0.5776	0.6696
19 nineteen	0.5630	0.5690	0.5690	0.5717	0.6126	0.6130	0.6517
20 twenty	0.4590	0.4868	0.4872	0.6916	0.7028	0.7152	0.7841
21 twenty1	0.2281	0.3742	0.3825	0.4236	0.4461	0.4476	0.4483
22 twenty2	0.1096	0.1871	0.1892	0.3858	0.6755	0.7488	0.7629
23 twenty3	0.4154	0.4219	0.4219	0.4958	0.5646	0.5702	0.5895
24 twenty4	0.6676	0.7061	0.7069	0.7093	0.7262	0.7263	0.7313
25 n	0.2134	0.2676	0.2685	0.3624	0.3650	0.3670	0.5339
26 twenty6	0.3988	0.4085	0.4086	0.4109	0.4247	0.4248	0.4950
27 twenty7	0.6504	0.6504	0.6504	0.6849	0.6987	0.6996	0.7365

28 twenty8	0.3311	0.4580	0.4640	0.4764	0.5104	0.5110
0.5154						
29 twenty9	0.2611	0.4606	0.4770	0.4771	0.4773	0.4773
0.5147						
30 thirty	0.4842	0.4849	0.4849	0.4914	0.5339	0.5348
0.5387						
31 thirty1	0.6568	0.6624	0.6625	0.6850	0.7702	0.7737
0.8677						
32 thirty2	0.7440	0.7514	0.7514	0.7529	0.8128	0.8140
0.8175						
33 thirty3	0.1000	0.2154	0.2203	0.2253	0.3346	0.3387
0.3886						
34 thirty4	0.0853	0.3411	0.3699	0.4280	0.4287	0.4295
0.4377						
35 thirty5	0.2978	0.3052	0.3053	0.4298	0.4303	0.4340
0.4816						
36 thirty6	0.6606	0.6783	0.6784	0.6823	0.6881	0.6882
0.6974						
37 thirty7	0.5895	0.5907	0.5907	0.6911	0.7266	0.7328
0.7356						
38 thirty8	0.5428	0.5440	0.5440	0.6321	0.6815	0.6867
0.6970						
39 thirty9	0.4920	0.5230	0.5233	0.5245	0.5791	0.5802
0.5820						
40 forty	0.5512	0.6567	0.6607	0.6610	0.6612	0.6612
0.6675						
41 forty1	0.6318	0.6413	0.6413	0.6514	0.7011	0.7024
0.7164						
42 forty2	0.2873	0.2965	0.2965	0.4016	0.4586	0.4675
0.5126						
43 forty3	0.4885	0.4944	0.4945	0.6106	0.6599	0.6691
0.6831						
44 forty4	0.5604	0.5674	0.5674	0.5718	0.5735	0.5735
0.5810						

Cumulative Communalities Matrix (continued)

	Factors 1 Thru						
	1	2	3	4	5	6	7
SORTS							
45 forty5	0.6879	0.6952	0.6952	0.7156	0.7318	0.7323	0.7341
cum% expl.Var.	47	52	53	57	61	61	64

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Factor Matrix with an X Indicating a Defining Sort

		Loadings				
QSORT		1	2	3	4	5
1	one	0.3578	0.6184X	0.0956	0.3007	0.0583
2	two	0.8081X	0.1528	0.1288	0.0722	0.2673
3	three	0.4423X	0.3382	0.0908	0.1368	-0.2033
4	four	0.5132X	0.1399	0.2685	0.2160	0.6060X
5	five	0.7439X	-0.0692	0.3326	0.2041	0.1488
6	six	0.7436X	-0.0975	0.1608	0.3232	0.3029
7	seven	0.8770X	0.1243	0.0476	0.0166	0.0564
8	eight	0.6908X	0.1926	0.3313	0.1174	0.3363
9	nine	0.6725X	0.0647	0.2456	0.0556	0.1374
10	ten	0.5345X	0.3490	0.3503	0.2283	0.4262X
11	eleven	0.5329X	0.2420	0.3160	0.1731	0.2944
12	twelve	0.4938X	0.2255	0.4043X	0.0923	0.3096
13	thirteen	0.6326X	0.1365	0.2029	0.2431	0.0972
14	fourteen	0.4286X	0.2820	0.3068	0.4329X	-0.0480
15	fifteen	0.7104X	0.1876	0.0374	0.3304	0.2716
16	sixteen	0.5990X	0.3923	0.0088	0.2748	0.1962
17	seventee	0.4492X	0.1894	0.4222X	0.3762	0.3408
18	eighteen	0.2635	0.4928X	0.1457	0.3866X	0.4220X
19	nineteen	0.4904X	0.3338	0.4369X	0.3052	0.0538
20	twenty	0.3042	0.1170	0.7070X	0.1330	0.3943X
21	twenty1	0.1626	0.1372	0.0569	0.6320X	-0.0164
22	twenty2	0.0314	0.8261X	0.2407	-0.0292	0.1075
23	twenty3	0.6554X	0.2870	-0.0325	0.2498	0.0785
24	twenty4	0.5752X	0.0286	0.3932X	0.3353	0.3631
25	n	0.0754	0.2463	0.6395X	0.2371	-0.0326
26	twenty6	0.4598X	-0.0555	0.4149X	0.3106	0.0999
27	twenty7	0.5783X	0.0141	0.3511	0.5118X	0.0945
28	twenty8	0.0828	0.2342	0.2392	0.5852X	0.2269
29	twenty9	0.0908	0.3785	0.0460	0.5769X	0.1278
30	thirty	0.4346X	0.0180	0.1853	0.4669X	0.3070
31	thirty1	0.3932X	0.1144	0.1817	0.4811X	0.6592X
32	thirty2	0.5151X	0.0101	0.4064X	0.4856X	0.3862X
33	thirty3	-0.0865	-0.0329	0.3498	0.5029X	0.0077
34	thirty4	-0.1832	0.3927X	0.1718	0.4322X	0.0991
35	thirty5	0.2555	0.1788	0.5588X	0.0886	0.2535
36	thirty6	0.4085X	0.2050	0.4137X	0.5089X	0.2245
37	thirty7	0.5633X	0.0078	0.0907	0.6071X	0.1725
38	thirty8	0.2884	0.1532	0.3819	0.3753	0.5504X
39	thirty9	0.3094	0.0736	0.2934	0.5896X	0.2121
40	forty	0.2980	0.3514	0.2253	0.5991X	0.1891
41	forty1	0.4361X	0.0958	0.1714	0.6135X	0.3270
42	forty2	0.3637	-0.0136	-0.1140	0.5658X	0.1858

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Factor Matrix with an X Indicating a Defining Sort (continued)

	Loadings				
QSORT	1	2	3	4	5
43 forty3	0.5883X	-0.1361	0.1820	0.5116X	0.0856
44 forty4	0.4775X	0.2620	0.1736	0.4424X	0.2180
45 forty5	0.6055X	0.0550	0.2101	0.4771X	0.2965
% expl.Var.	24	7	9	15	8

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Free Distribution Data Results

QSORT		MEAN	ST.DEV.
1	one	0.000	2.380
2	two	0.000	2.380
3	three	0.000	2.380
4	four	0.000	2.380
5	five	0.000	2.380
6	six	0.000	2.380
7	seven	0.000	2.380
8	eight	0.000	2.380
9	nine	0.000	2.380
10	ten	0.000	2.380
11	eleven	0.000	2.380
12	twelve	0.000	2.380
13	thirteen	0.000	2.380
14	fourteen	0.000	2.380
15	fifteen	0.000	2.380
16	sixteen	0.000	2.380
17	seventee	0.000	2.380
18	eighteen	0.000	2.380
19	nineteen	0.000	2.380
20	twenty	0.000	2.380
21	twenty1	0.000	2.380
22	twenty2	0.000	2.380
23	twenty3	0.000	2.380
24	twenty4	0.000	2.380
25	n	0.000	2.380
26	twenty6	0.000	2.380
27	twenty7	0.000	2.380
28	twenty8	0.000	2.380
29	twenty9	0.000	2.380
30	thirty	0.000	2.380
31	thirty1	0.000	2.380
32	thirty2	0.000	2.380
33	thirty3	0.000	2.380
34	thirty4	0.000	2.380
35	thirty5	0.000	2.380
36	thirty6	0.000	2.380
37	thirty7	0.000	2.380
38	thirty8	0.000	2.380
39	thirty9	0.000	2.380
40	forty	0.000	2.380
41	forty1	0.000	2.380
42	forty2	0.000	2.380
43	forty3	0.000	2.380
44	forty4	0.000	2.380

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Free Distribution Data Results

QSORT	MEAN	ST.DEV.
45 forty5	0.000	2.380

Rank Statement Totals with Each Factor

No.	Statement	No.	1	2	3	4	5
1	1. The Passivhaus standard is well understood in the U	1	-0.97	34	-0.89	34	-1.26	42	-1.42	41	-1.40	39
2	2. Passivhaus buildings offer good comfort for occupan	2	2.13	1	1.97	1	1.43	5	1.57	2	1.23	6
3	3. Passivhaus components are affordable in the UK	3	-0.43	24	-0.44	28	-0.45	27	-0.82	34	-0.54	33
4	4. There is a mature supply chain for Passivhaus compo	4	-1.12	37	-1.67	42	-1.17	38	-1.24	40	-1.09	37
5	5. There are financial incentives to build Passivhaus	5	-0.43	25	-0.85	33	-0.87	34	-1.03	35	-1.51	41
6	6. Passivhaus designs are too expensive	6	-0.10	22	0.20	19	-0.46	28	0.40	16	-0.45	30
7	7. The UK responds well to the Passivhaus German langu	7	-0.52	28	-1.20	38	-0.66	30	-0.43	28	-1.17	38
8	8. Passivhaus is appropriate for the UK climate	8	1.45	3	0.91	12	0.91	10	1.28	8	0.78	12
9	9. UK construction skills are appropriate to build Pas	9	-0.66	29	0.46	15	-0.32	25	-1.97	43	-0.53	32
10	10. UK design skills are appropriate to design Passivh	10	-0.50	26	0.19	20	0.31	15	-0.65	31	-0.07	19
11	11. SAP is a more appropriate software for low energy	11	-1.58	43	-0.50	30	-1.19	40	-0.69	32	-1.43	40
12	12. The Passivhaus standard is very flexible	12	0.88	12	-0.98	35	0.60	12	-0.16	22	0.58	14
13	13. The Code for Sustainable Homes is a better standar	13	-1.19	38	-0.03	22	-0.89	35	-0.51	30	-2.02	43
14	14. The German name Passivhaus is appropriate for the	14	0.52	16	-0.59	32	-0.10	22	0.69	12	-0.14	22
15	15. The UK has many existing Passivhaus buildings to l	15	-0.95	32	-2.29	43	-1.18	39	-1.69	42	-1.76	42
16	16. We understand building fabric performance well in	16	-1.27	41	1.00	10	0.02	19	-0.41	27	-0.23	26
17	17. The materials used to construct Passivhaus designs	17	-0.98	36	0.15	21	-0.05	20	-0.32	25	-0.12	21
18	18. Passivhaus buildings are restrictive for occupants	18	-0.97	35	-1.26	39	-0.97	36	-0.19	24	-0.45	29
19	19. The Passivhaus standard will only catch on if the	19	0.45	17	0.62	13	1.46	4	1.06	10	1.14	7
20	20. The UK Government only looks to BRE to develop bui	20	0.39	18	-0.48	29	0.14	18	0.00	19	0.89	10
21	21. People associate low energy building performance w	21	1.11	9	0.28	17	1.40	7	1.55	4	1.46	3
22	22. UK procurement methods work well to deliver Passiv	22	-0.52	27	-0.98	36	-0.87	33	-1.18	39	-0.57	34
23	23. The UK construction industry has a fast-buck menta	23	1.02	11	0.25	18	2.18	1	1.56	3	1.28	5
24	24. Passivhaus buildings have to perform as specified	24	1.11	8	1.82	2	0.88	11	1.38	7	0.90	9
25	25. UK current legislation favours Passivhaus design	25	-0.95	33	-1.37	40	-1.20	41	-0.38	26	-1.05	36
26	26. MVHR uses more energy than it saves	26	-1.35	42	-0.20	25	-1.03	37	-0.45	29	-1.05	35

27	27. Our planning system supports the Passivhaus standa	27	-0.69	30	-0.19	24	-1.89	43	-0.74	33	-0.53	31			
28	28. PHPP is developed well for UK design scenarios	28	0.63	14	-0.32	26	0.27	17	0.18	18	0.23	17			
29	29. The use of MVHR improves indoor air-quality	29	1.50	2	0.97	11	1.08	8	0.57	14	0.67	13			
30	30. We understand how to detail buildings well in the	30	-1.26	39	1.13	6	-0.25	24	-1.07	37	-0.29	27			
31	31. UK construction types are appropriate for Passivha	31	0.24	20	-1.00	37	-0.05	21	-0.03	20	0.18	18			
32	32. There is a market for Passivhaus designs in the UK	32	1.02	10	1.20	5	1.03	9	1.06	9	0.58	15			
33	33. Passivhaus designs work well with UK building desi	33	0.56	15	0.52	14	0.35	13	0.22	17	0.27	16			
34	34. People in the UK are frightened by the high degree	34	1.25	6	-0.42	27	0.30	16	1.48	5	1.71	2			
35	35. The UK has a lack of ambition when it comes to bui	35	0.69	13	-1.43	41	1.55	3	0.60	13	0.96	8			
36	36. Passivhaus designs are future proof	36	1.30	4	1.21	4	1.40	6	0.70	11	0.85	11			
37	37. Passivhaus buildings are difficult to construct	37	-0.05	21	-0.15	23	-0.78	31	0.51	15	-0.15	23			
38	38. We understand building energy performance well in	38	-1.26	40	1.51	3	-0.40	26	-0.14	21	-0.10	20			
39	39. In the UK there is a good communication between co	39	-0.92	31	0.28	16	-0.85	32	-1.18	38	-0.38	28			
40	40. There is a good communication between different me	40	-0.38	23	1.01	9	-0.17	23	-1.07	36	-0.19	25			
41	41. UK clients are ready to adopt the Passivhaus stand	41	0.34	19	-0.55	31	-0.61	29	-0.18	23	-0.18	24			
42	42. The Passivhaus standard is appropriate for new and	42	1.20	7	1.02	8	0.32	14	1.39	6	1.43	4			
43	43. The Passivhaus standard needs strong and coherent	43	1.25	5	1.10	7	2.02	2	1.71	1	2.25	1			

Rank Statement Totals with Each Factor

Factors
No. Statement No. 1
2 3 4 5

Correlations Between Factor Scores

	1	2	3	4	5
1	1.0000	0.3964	0.8065	0.8241	0.8332
2	0.3964	1.0000	0.5295	0.4720	0.5193
3	0.8065	0.5295	1.0000	0.7781	0.8613
4	0.8241	0.4720	0.7781	1.0000	0.8309
5	0.8332	0.5193	0.8613	0.8309	1.0000

Normalized Factor Scores -- For Factor 1

No.	Statement	No.	Z-SCORES
2	2. Passivhaus buildings offer good comfort for occupants	2	2.131
29	29. The use of MVHR improves indoor air-quality	29	1.502
8	8. Passivhaus is appropriate for the UK climate	8	1.454
36	36. Passivhaus designs are future proof	36	1.299
43	43. The Passivhaus standard needs strong and coherent repres	43	1.254
34	34. People in the UK are frightened by the high degree of ai	34	1.251
42	42. The Passivhaus standard is appropriate for new and refur	42	1.203
24	24. Passivhaus buildings have to perform as specified to wor	24	1.113
21	21. People associate low energy building performance with on	21	1.112
32	32. There is a market for Passivhaus designs in the UK	32	1.025
23	23. The UK construction industry has a fast-buck mentality	23	1.020
12	12. The Passivhaus standard is very flexible	12	0.882
35	35. The UK has a lack of ambition when it comes to building	35	0.694
28	28. PHPP is developed well for UK design scenarios	28	0.626
33	33. Passivhaus designs work well with UK building design aes	33	0.559
14	14. The German name Passivhaus is appropriate for the UK mar	14	0.523
19	19. The Passivhaus standard will only catch on if the major	19	0.450
20	20. The UK Government only looks to BRE to develop building	20	0.386
41	41. UK clients are ready to adopt the Passivhaus standard	41	0.341
31	31. UK construction types are appropriate for Passivhaus des	31	0.236
37	37. Passivhaus buildings are difficult to construct	37	-0.054
6	6. Passivhaus designs are too expensive	6	-0.101
40	40. There is a good communication between different members	40	-0.383
3	3. Passivhaus components are affordable in the UK	3	-0.433
5	5. There are financial incentives to build Passivhaus design	5	-0.435
10	10. UK design skills are appropriate to design Passivhaus de	10	-0.499

22	22. UK procurement methods work well to deliver Passivhaus d	22	-
0.520			
7	7. The UK responds well to the Passivhaus German language pr	7	-
0.521			
9	9. UK construction skills are appropriate to build Passivhau	9	-
0.657			
27	27. Our planning system supports the Passivhaus standard wel	27	-
0.687			
39	39. In the UK there is a good communication between construc	39	-
0.915			
15	15. The UK has many existing Passivhaus buildings to learn f	15	-
0.948			
25	25. UK current legislation favours Passivhaus design	25	-
0.953			
1	1. The Passivhaus standard is well understood in the UK	1	-
0.969			
18	18. Passivhaus buildings are restrictive for occupants	18	-
0.975			
17	17. The materials used to construct Passivhaus designs have	17	-
0.984			
4	4. There is a mature supply chain for Passivhaus components	4	-
1.125			
13	13. The Code for Sustainable Homes is a better standard than	13	-
1.195			
30	30. We understand how to detail buildings well in the UK	30	-
1.255			
38	38. We understand building energy performance well in the UK	38	-
1.258			
16	16. We understand building fabric performance well in the UK	16	-
1.270			
26	26. MVHR uses more energy than it saves	26	-
1.346			
11	11. SAP is a more appropriate software for low energy buildi	11	-
1.576			

Normalized Factor Scores -- For Factor 1

No.	Statement	No.	Z-SCORES

Normalized Factor Scores -- For Factor 2

No.	Statement	No.	Z-SCORES
2	2. Passivhaus buildings offer good comfort for occupants	2	1.972
24	24. Passivhaus buildings have to perform as specified to wor	24	1.816
38	38. We understand building energy performance well in the UK	38	1.508
36	36. Passivhaus designs are future proof	36	1.213
32	32. There is a market for Passivhaus designs in the UK	32	1.203
30	30. We understand how to detail buildings well in the UK	30	1.127
43	43. The Passivhaus standard needs strong and coherent repres	43	1.099
42	42. The Passivhaus standard is appropriate for new and refur	42	1.015
40	40. There is a good communication between different members	40	1.014
16	16. We understand building fabric performance well in the UK	16	0.999
29	29. The use of MVHR improves indoor air-quality	29	0.975
8	8. Passivhaus is appropriate for the UK climate	8	0.915
19	19. The Passivhaus standard will only catch on if the major	19	0.621
33	33. Passivhaus designs work well with UK building design aes	33	0.516
9	9. UK construction skills are appropriate to build Passivhau	9	0.455
39	39. In the UK there is a good communication between construc	39	0.280
21	21. People associate low energy building performance with on	21	0.276
23	23. The UK construction industry has a fast-buck mentality	23	0.255
6	6. Passivhaus designs are too expensive	6	0.196
10	10. UK design skills are appropriate to design Passivhaus de	10	0.190
17	17. The materials used to construct Passivhaus designs have	17	0.150
13	13. The Code for Sustainable Homes is a better standard than	13	-0.030
37	37. Passivhaus buildings are difficult to construct	37	-0.152
27	27. Our planning system supports the Passivhaus standard wel	27	-0.186
26	26. MVHR uses more energy than it saves	26	-0.203
28	28. PHPP is developed well for UK design scenarios	28	-0.318

34	34. People in the UK are frightened by the high degree of ai	34	-
0.423			
3	3. Passivhaus components are affordable in the UK	3	-
0.444			
20	20. The UK Government only looks to BRE to develop building	20	-
0.484			
11	11. SAP is a more appropriate software for low energy buildi	11	-
0.502			
41	41. UK clients are ready to adopt the Passivhaus standard	41	-
0.553			
14	14. The German name Passivhaus is appropriate for the UK mar	14	-
0.587			
5	5. There are financial incentives to build Passivhaus design	5	-
0.851			
1	1. The Passivhaus standard is well understood in the UK	1	-
0.889			
12	12. The Passivhaus standard is very flexible	12	-
0.977			
22	22. UK procurement methods work well to deliver Passivhaus d	22	-
0.979			
31	31. UK construction types are appropriate for Passivhaus des	31	-
0.999			
7	7. The UK responds well to the Passivhaus German language pr	7	-
1.195			
18	18. Passivhaus buildings are restrictive for occupants	18	-
1.262			
25	25. UK current legislation favours Passivhaus design	25	-
1.371			
35	35. The UK has a lack of ambition when it comes to building	35	-
1.430			
4	4. There is a mature supply chain for Passivhaus components	4	-
1.666			
15	15. The UK has many existing Passivhaus buildings to learn f	15	-
2.294			

Normalized Factor Scores -- For Factor 2

No.	Statement	No.	Z-SCORES

Normalized Factor Scores -- For Factor 3

No.	Statement	No.	Z-SCORES
23	23. The UK construction industry has a fast-buck mentality	23	2.176
43	43. The Passivhaus standard needs strong and coherent repres	43	2.017
35	35. The UK has a lack of ambition when it comes to building	35	1.553
19	19. The Passivhaus standard will only catch on if the major	19	1.459
2	2. Passivhaus buildings offer good comfort for occupants	2	1.429
36	36. Passivhaus designs are future proof	36	1.403
21	21. People associate low energy building performance with on	21	1.397
29	29. The use of MVHR improves indoor air-quality	29	1.080
32	32. There is a market for Passivhaus designs in the UK	32	1.030
8	8. Passivhaus is appropriate for the UK climate	8	0.909
24	24. Passivhaus buildings have to perform as specified to wor	24	0.884
12	12. The Passivhaus standard is very flexible	12	0.597
33	33. Passivhaus designs work well with UK building design aes	33	0.351
42	42. The Passivhaus standard is appropriate for new and refur	42	0.321
10	10. UK design skills are appropriate to design Passivhaus de	10	0.308
34	34. People in the UK are frightened by the high degree of ai	34	0.304
28	28. PHPP is developed well for UK design scenarios	28	0.268
20	20. The UK Government only looks to BRE to develop building	20	0.142
16	16. We understand building fabric performance well in the UK	16	0.025
17	17. The materials used to construct Passivhaus designs have	17	-0.048
31	31. UK construction types are appropriate for Passivhaus des	31	-0.048
14	14. The German name Passivhaus is appropriate for the UK mar	14	-0.096
40	40. There is a good communication between different members	40	-0.168
30	30. We understand how to detail buildings well in the UK	30	-0.250
9	9. UK construction skills are appropriate to build Passivhau	9	-0.322
38	38. We understand building energy performance well in the UK	38	-0.397

3	3. Passivhaus components are affordable in the UK	3	-	0.449
6	6. Passivhaus designs are too expensive	6	-	0.463
41	41. UK clients are ready to adopt the Passivhaus standard	41	-	0.611
7	7. The UK responds well to the Passivhaus German language pr	7	-	0.658
37	37. Passivhaus buildings are difficult to construct	37	-	0.783
39	39. In the UK there is a good communication between construc	39	-	0.848
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.868
5	5. There are financial incentives to build Passivhaus design	5	-	0.871
13	13. The Code for Sustainable Homes is a better standard than	13	-	0.892
18	18. Passivhaus buildings are restrictive for occupants	18	-	0.965
26	26. MVHR uses more energy than it saves	26	-	1.030
4	4. There is a mature supply chain for Passivhaus components	4	-	1.169
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	1.178
11	11. SAP is a more appropriate software for low energy buildi	11	-	1.188
25	25. UK current legislation favours Passivhaus design	25	-	1.200
1	1. The Passivhaus standard is well understood in the UK	1	-	1.258
27	27. Our planning system supports the Passivhaus standard wel	27	-	1.893

Normalized Factor Scores -- For Factor 3

No.	Statement	No.	Z-SCORES

Normalized Factor Scores -- For Factor 4

No.	Statement	No.	Z-SCORES
43	43. The Passivhaus standard needs strong and coherent repres	43	1.711
2	2. Passivhaus buildings offer good comfort for occupants	2	1.575
23	23. The UK construction industry has a fast-buck mentality	23	1.556
21	21. People associate low energy building performance with on	21	1.551
34	34. People in the UK are frightened by the high degree of ai	34	1.480
42	42. The Passivhaus standard is appropriate for new and refur	42	1.391
24	24. Passivhaus buildings have to perform as specified to wor	24	1.378
8	8. Passivhaus is appropriate for the UK climate	8	1.280
32	32. There is a market for Passivhaus designs in the UK	32	1.063
19	19. The Passivhaus standard will only catch on if the major	19	1.057
36	36. Passivhaus designs are future proof	36	0.697
14	14. The German name Passivhaus is appropriate for the UK mar	14	0.694
35	35. The UK has a lack of ambition when it comes to building	35	0.595
29	29. The use of MVHR improves indoor air-quality	29	0.573
37	37. Passivhaus buildings are difficult to construct	37	0.514
6	6. Passivhaus designs are too expensive	6	0.403
33	33. Passivhaus designs work well with UK building design aes	33	0.219
28	28. PHPP is developed well for UK design scenarios	28	0.179
20	20. The UK Government only looks to BRE to develop building	20	0.001
31	31. UK construction types are appropriate for Passivhaus des	31	-0.025
38	38. We understand building energy performance well in the UK	38	-0.136
12	12. The Passivhaus standard is very flexible	12	-0.155
41	41. UK clients are ready to adopt the Passivhaus standard	41	-0.176
18	18. Passivhaus buildings are restrictive for occupants	18	-0.189
17	17. The materials used to construct Passivhaus designs have	17	-0.324
25	25. UK current legislation favours Passivhaus design	25	-0.378

16	16. We understand building fabric performance well in the UK	16	-
0.408			
7	7. The UK responds well to the Passivhaus German language pr	7	-
0.429			
26	26. MVHR uses more energy than it saves	26	-
0.449			
13	13. The Code for Sustainable Homes is a better standard than	13	-
0.506			
10	10. UK design skills are appropriate to design Passivhaus de	10	-
0.646			
11	11. SAP is a more appropriate software for low energy buildi	11	-
0.687			
27	27. Our planning system supports the Passivhaus standard wel	27	-
0.740			
3	3. Passivhaus components are affordable in the UK	3	-
0.818			
5	5. There are financial incentives to build Passivhaus design	5	-
1.034			
40	40. There is a good communication between different members	40	-
1.067			
30	30. We understand how to detail buildings well in the UK	30	-
1.071			
39	39. In the UK there is a good communication between construc	39	-
1.179			
22	22. UK procurement methods work well to deliver Passivhaus d	22	-
1.181			
4	4. There is a mature supply chain for Passivhaus components	4	-
1.235			
1	1. The Passivhaus standard is well understood in the UK	1	-
1.424			
15	15. The UK has many existing Passivhaus buildings to learn f	15	-
1.685			
9	9. UK construction skills are appropriate to build Passivhau	9	-
1.975			

Normalized Factor Scores -- For Factor 4

No.	Statement	No.	Z-SCORES

Normalized Factor Scores -- For Factor 5

No.	Statement	No.	Z-SCORES
43	43. The Passivhaus standard needs strong and coherent repres	43	2.251
34	34. People in the UK are frightened by the high degree of ai	34	1.709
21	21. People associate low energy building performance with on	21	1.461
42	42. The Passivhaus standard is appropriate for new and refur	42	1.432
23	23. The UK construction industry has a fast-buck mentality	23	1.284
2	2. Passivhaus buildings offer good comfort for occupants	2	1.226
19	19. The Passivhaus standard will only catch on if the major	19	1.141
35	35. The UK has a lack of ambition when it comes to building	35	0.962
24	24. Passivhaus buildings have to perform as specified to wor	24	0.904
20	20. The UK Government only looks to BRE to develop building	20	0.890
36	36. Passivhaus designs are future proof	36	0.853
8	8. Passivhaus is appropriate for the UK climate	8	0.776
29	29. The use of MVHR improves indoor air-quality	29	0.672
12	12. The Passivhaus standard is very flexible	12	0.584
32	32. There is a market for Passivhaus designs in the UK	32	0.576
33	33. Passivhaus designs work well with UK building design aes	33	0.266
28	28. PHPP is developed well for UK design scenarios	28	0.234
31	31. UK construction types are appropriate for Passivhaus des	31	0.179
10	10. UK design skills are appropriate to design Passivhaus de	10	-0.074
38	38. We understand building energy performance well in the UK	38	-0.096
17	17. The materials used to construct Passivhaus designs have	17	-0.116
14	14. The German name Passivhaus is appropriate for the UK mar	14	-0.140
37	37. Passivhaus buildings are difficult to construct	37	-0.151
41	41. UK clients are ready to adopt the Passivhaus standard	41	-0.183
40	40. There is a good communication between different members	40	-0.188
16	16. We understand building fabric performance well in the UK	16	-0.231

30	30. We understand how to detail buildings well in the UK	30	-	0.294
39	39. In the UK there is a good communication between construc	39	-	0.379
18	18. Passivhaus buildings are restrictive for occupants	18	-	0.446
6	6. Passivhaus designs are too expensive	6	-	0.450
27	27. Our planning system supports the Passivhaus standard wel	27	-	0.528
9	9. UK construction skills are appropriate to build Passivhau	9	-	0.535
3	3. Passivhaus components are affordable in the UK	3	-	0.542
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.575
26	26. MVHR uses more energy than it saves	26	-	1.048
25	25. UK current legislation favours Passivhaus design	25	-	1.049
4	4. There is a mature supply chain for Passivhaus components	4	-	1.085
7	7. The UK responds well to the Passivhaus German language pr	7	-	1.170
1	1. The Passivhaus standard is well understood in the UK	1	-	1.399
11	11. SAP is a more appropriate software for low energy buildi	11	-	1.430
5	5. There are financial incentives to build Passivhaus design	5	-	1.508
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	1.760
13	13. The Code for Sustainable Homes is a better standard than	13	-	2.024

Normalized Factor Scores -- For Factor 5

No.	Statement	No.	Z-SCORES

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Descending Array of Differences Between Factors 1 and 2

No.	Statement	No.	Type 1	Type 2	Difference
35	35. The UK has a lack of ambition when it comes to building	35			0.694
12	12. The Passivhaus standard is very flexible	12			0.882
34	34. People in the UK are frightened by the high degree of ai	34			1.251
15	15. The UK has many existing Passivhaus buildings to learn f	15	-		0.948
31	31. UK construction types are appropriate for Passivhaus des	31			0.236
14	14. The German name Passivhaus is appropriate for the UK mar	14			0.523
28	28. PHPP is developed well for UK design scenarios	28			0.626
41	41. UK clients are ready to adopt the Passivhaus standard	41			0.341
20	20. The UK Government only looks to BRE to develop building	20			0.386
21	21. People associate low energy building performance with on	21			1.112
23	23. The UK construction industry has a fast-buck mentality	23			1.020
7	7. The UK responds well to the Passivhaus German language pr	7	-		0.521
4	4. There is a mature supply chain for Passivhaus components	4	-		1.125
8	8. Passivhaus is appropriate for the UK climate	8			1.454
29	29. The use of MVHR improves indoor air-quality	29			1.502
22	22. UK procurement methods work well to deliver Passivhaus d	22	-		0.520
25	25. UK current legislation favours Passivhaus design	25	-		0.953
5	5. There are financial incentives to build Passivhaus design	5	-		0.435
18	18. Passivhaus buildings are restrictive for occupants	18	-		0.975
42	42. The Passivhaus standard is appropriate for new and refur	42			1.203
2	2. Passivhaus buildings offer good comfort for occupants	2			2.131
43	43. The Passivhaus standard needs strong and coherent repres	43			1.254
37	37. Passivhaus buildings are difficult to construct	37	-		0.054
36	36. Passivhaus designs are future proof	36			1.299
33	33. Passivhaus designs work well with UK building design aes	33			0.559
3	3. Passivhaus components are affordable in the UK	3	-		0.433

No.	Statement	No.	Type 1	Type 2	Difference
35	35. The UK has a lack of ambition when it comes to building	35			0.694
				-1.430	2.124
12	12. The Passivhaus standard is very flexible	12			0.882
				-0.977	1.859
34	34. People in the UK are frightened by the high degree of ai	34			1.251
				-0.423	1.674
15	15. The UK has many existing Passivhaus buildings to learn f	15	-		0.948
				-2.294	1.346
31	31. UK construction types are appropriate for Passivhaus des	31			0.236
				-0.999	1.235
14	14. The German name Passivhaus is appropriate for the UK mar	14			0.523
				-0.587	1.110
28	28. PHPP is developed well for UK design scenarios	28			0.626
				-0.318	0.944
41	41. UK clients are ready to adopt the Passivhaus standard	41			0.341
				-0.553	0.894
20	20. The UK Government only looks to BRE to develop building	20			0.386
				-0.484	0.870
21	21. People associate low energy building performance with on	21			1.112
				0.276	0.836
23	23. The UK construction industry has a fast-buck mentality	23			1.020
				0.255	0.765
7	7. The UK responds well to the Passivhaus German language pr	7	-		0.521
				-1.195	0.674
4	4. There is a mature supply chain for Passivhaus components	4	-		1.125
				-1.666	0.541
8	8. Passivhaus is appropriate for the UK climate	8			1.454
				0.915	0.540
29	29. The use of MVHR improves indoor air-quality	29			1.502
				0.975	0.527
22	22. UK procurement methods work well to deliver Passivhaus d	22	-		0.520
				-0.979	0.460
25	25. UK current legislation favours Passivhaus design	25	-		0.953
				-1.371	0.418
5	5. There are financial incentives to build Passivhaus design	5	-		0.435
				-0.851	0.416
18	18. Passivhaus buildings are restrictive for occupants	18	-		0.975
				-1.262	0.287
42	42. The Passivhaus standard is appropriate for new and refur	42			1.203
				1.015	0.188
2	2. Passivhaus buildings offer good comfort for occupants	2			2.131
				1.972	0.159
43	43. The Passivhaus standard needs strong and coherent repres	43			1.254
				1.099	0.154
37	37. Passivhaus buildings are difficult to construct	37	-		0.054
				-0.152	0.098
36	36. Passivhaus designs are future proof	36			1.299
				1.213	0.086
33	33. Passivhaus designs work well with UK building design aes	33			0.559
				0.516	0.043
3	3. Passivhaus components are affordable in the UK	3	-		0.433
				-0.444	0.011

1	1. The Passivhaus standard is well understood in the UK	1	-		
0.969	-0.889	-0.080			
19	19. The Passivhaus standard will only catch on if the major	19			
0.450	0.621	-0.171			
32	32. There is a market for Passivhaus designs in the UK	32			
1.025	1.203	-0.178			
6	6. Passivhaus designs are too expensive	6	-		
0.101	0.196	-0.297			
27	27. Our planning system supports the Passivhaus standard wel	27	-		
0.687	-0.186	-0.501			
10	10. UK design skills are appropriate to design Passivhaus de	10	-		
0.499	0.190	-0.690			
24	24. Passivhaus buildings have to perform as specified to wor	24			
1.113	1.816	-0.704			
11	11. SAP is a more appropriate software for low energy buildi	11	-		
1.576	-0.502	-1.074			
9	9. UK construction skills are appropriate to build Passivhau	9	-		
0.657	0.455	-1.112			
17	17. The materials used to construct Passivhaus designs have	17	-		
0.984	0.150	-1.134			
26	26. MVHR uses more energy than it saves	26	-		
1.346	-0.203	-1.144			
13	13. The Code for Sustainable Homes is a better standard than	13	-		
1.195	-0.030	-1.165			
39	39. In the UK there is a good communication between construc	39	-		
0.915	0.280	-1.196			
40	40. There is a good communication between different members	40	-		
0.383	1.014	-1.397			
16	16. We understand building fabric performance well in the UK	16	-		
1.270	0.999	-2.269			
30	30. We understand how to detail buildings well in the UK	30	-		
1.255	1.127	-2.382			
38	38. We understand building energy performance well in the UK	38	-		
1.258	1.508	-2.766			

Descending Array of Differences Between Factors 1 and 2

No.	Statement	No.	Type	1	Type	2	Difference

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Descending Array of Differences Between Factors 1 and 3

No.	Statement	No.	Type 1	Type 3	Difference
27	27. Our planning system supports the Passivhaus standard wel	27	-	0.687	-1.893	1.207
41	41. UK clients are ready to adopt the Passivhaus standard	41		0.341	-0.611	0.953
34	34. People in the UK are frightened by the high degree of ai	34		1.251	0.304	0.946
42	42. The Passivhaus standard is appropriate for new and refur	42		1.203	0.321	0.882
37	37. Passivhaus buildings are difficult to construct	37	-	0.054	-0.783	0.729
2	2. Passivhaus buildings offer good comfort for occupants	2		2.131	1.429	0.701
14	14. The German name Passivhaus is appropriate for the UK mar	14		0.523	-0.096	0.619
8	8. Passivhaus is appropriate for the UK climate	8		1.454	0.909	0.545
5	5. There are financial incentives to build Passivhaus design	5	-	0.435	-0.871	0.436
29	29. The use of MVHR improves indoor air-quality	29		1.502	1.080	0.422
6	6. Passivhaus designs are too expensive	6	-	0.101	-0.463	0.361
28	28. PHPP is developed well for UK design scenarios	28		0.626	0.268	0.357
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.520	-0.868	0.349
1	1. The Passivhaus standard is well understood in the UK	1	-	0.969	-1.258	0.288
12	12. The Passivhaus standard is very flexible	12		0.882	0.597	0.285
31	31. UK construction types are appropriate for Passivhaus des	31		0.236	-0.048	0.284
25	25. UK current legislation favours Passivhaus design	25	-	0.953	-1.200	0.247
20	20. The UK Government only looks to BRE to develop building	20		0.386	0.142	0.244
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	0.948	-1.178	0.230
24	24. Passivhaus buildings have to perform as specified to wor	24		1.113	0.884	0.229
33	33. Passivhaus designs work well with UK building design aes	33		0.559	0.351	0.208
7	7. The UK responds well to the Passivhaus German language pr	7	-	0.521	-0.658	0.137
4	4. There is a mature supply chain for Passivhaus components	4	-	1.125	-1.169	0.044
3	3. Passivhaus components are affordable in the UK	3	-	0.433	-0.449	0.016
32	32. There is a market for Passivhaus designs in the UK	32		1.025	1.030	-0.005
18	18. Passivhaus buildings are restrictive for occupants	18	-	0.975	-0.965	-0.009

39	39. In the UK there is a good communication between construc	39	-			
0.915	-0.848	-0.067				
36	36. Passivhaus designs are future proof	36				
1.299	1.403	-0.104				
40	40. There is a good communication between different members	40	-			
0.383	-0.168	-0.215				
21	21. People associate low energy building performance with on	21				
1.112	1.397	-0.285				
13	13. The Code for Sustainable Homes is a better standard than	13	-			
1.195	-0.892	-0.303				
26	26. MVHR uses more energy than it saves	26	-			
1.346	-1.030	-0.317				
9	9. UK construction skills are appropriate to build Passivhau	9	-			
0.657	-0.322	-0.335				
11	11. SAP is a more appropriate software for low energy buildi	11	-			
1.576	-1.188	-0.387				
43	43. The Passivhaus standard needs strong and coherent repres	43				
1.254	2.017	-0.763				
10	10. UK design skills are appropriate to design Passivhaus de	10	-			
0.499	0.308	-0.808				
35	35. The UK has a lack of ambition when it comes to building	35				
0.694	1.553	-0.859				
38	38. We understand building energy performance well in the UK	38	-			
1.258	-0.397	-0.861				
17	17. The materials used to construct Passivhaus designs have	17	-			
0.984	-0.048	-0.936				
30	30. We understand how to detail buildings well in the UK	30	-			
1.255	-0.250	-1.005				
19	19. The Passivhaus standard will only catch on if the major	19				
0.450	1.459	-1.009				
23	23. The UK construction industry has a fast-buck mentality	23				
1.020	2.176	-1.157				
16	16. We understand building fabric performance well in the UK	16	-			
1.270	0.025	-1.295				

Descending Array of Differences Between Factors 1 and 3

No.	Statement	No.	Type
1	Type 3 Difference		

Descending Array of Differences Between Factors 1 and 4

No.	Statement	No.	Type	1	Type	4	Difference
9	9. UK construction skills are appropriate to build Passivhau	9	-	0.657		-1.975	1.318
12	12. The Passivhaus standard is very flexible	12		0.882		-0.155	1.037
29	29. The use of MVHR improves indoor air-quality	29		1.502		0.573	0.929
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	0.948		-1.685	0.737
40	40. There is a good communication between different members	40	-	0.383		-1.067	0.684
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.520		-1.181	0.661
36	36. Passivhaus designs are future proof	36		1.299		0.697	0.602
5	5. There are financial incentives to build Passivhaus design	5	-	0.435		-1.034	0.599
2	2. Passivhaus buildings offer good comfort for occupants	2		2.131		1.575	0.556
41	41. UK clients are ready to adopt the Passivhaus standard	41		0.341		-0.176	0.518
1	1. The Passivhaus standard is well understood in the UK	1	-	0.969		-1.424	0.455
28	28. PHPP is developed well for UK design scenarios	28		0.626		0.179	0.446
3	3. Passivhaus components are affordable in the UK	3	-	0.433		-0.818	0.385
20	20. The UK Government only looks to BRE to develop building	20		0.386		0.001	0.384
33	33. Passivhaus designs work well with UK building design aes	33		0.559		0.219	0.340
39	39. In the UK there is a good communication between construc	39	-	0.915		-1.179	0.264
31	31. UK construction types are appropriate for Passivhaus des	31		0.236		-0.025	0.261
8	8. Passivhaus is appropriate for the UK climate	8		1.454		1.280	0.174
10	10. UK design skills are appropriate to design Passivhaus de	10	-	0.499		-0.646	0.147
4	4. There is a mature supply chain for Passivhaus components	4	-	1.125		-1.235	0.110
35	35. The UK has a lack of ambition when it comes to building	35		0.694		0.595	0.099
27	27. Our planning system supports the Passivhaus standard wel	27	-	0.687		-0.740	0.053
32	32. There is a market for Passivhaus designs in the UK	32		1.025		1.063	-0.039
7	7. The UK responds well to the Passivhaus German language pr	7	-	0.521		-0.429	-0.093
14	14. The German name Passivhaus is appropriate for the UK mar	14		0.523		0.694	-0.171
30	30. We understand how to detail buildings well in the UK	30	-	1.255		-1.071	-0.184

42	42. The Passivhaus standard is appropriate for new and refur	42			
1.203	1.391	-0.188			
34	34. People in the UK are frightened by the high degree of ai	34			
1.251	1.480	-0.229			
24	24. Passivhaus buildings have to perform as specified to wor	24			
1.113	1.378	-0.265			
21	21. People associate low energy building performance with on	21			
1.112	1.551	-0.439			
43	43. The Passivhaus standard needs strong and coherent repres	43			
1.254	1.711	-0.457			
6	6. Passivhaus designs are too expensive	6	-		
0.101	0.403	-0.504			
23	23. The UK construction industry has a fast-buck mentality	23			
1.020	1.556	-0.536			
37	37. Passivhaus buildings are difficult to construct	37	-		
0.054	0.514	-0.568			
25	25. UK current legislation favours Passivhaus design	25	-		
0.953	-0.378	-0.575			
19	19. The Passivhaus standard will only catch on if the major	19			
0.450	1.057	-0.607			
17	17. The materials used to construct Passivhaus designs have	17	-		
0.984	-0.324	-0.660			
13	13. The Code for Sustainable Homes is a better standard than	13	-		
1.195	-0.506	-0.689			
18	18. Passivhaus buildings are restrictive for occupants	18	-		
0.975	-0.189	-0.786			
16	16. We understand building fabric performance well in the UK	16	-		
1.270	-0.408	-0.862			
11	11. SAP is a more appropriate software for low energy buildi	11	-		
1.576	-0.687	-0.889			
26	26. MVHR uses more energy than it saves	26	-		
1.346	-0.449	-0.897			
38	38. We understand building energy performance well in the UK	38	-		
1.258	-0.136	-1.122			

Descending Array of Differences Between Factors 1 and 4

No.	Statement	No.	Type
1	Type 4 Difference		

Descending Array of Differences Between Factors 1 and 5

No.	Statement	No.	Type	1	Type	5	Difference
5	5. There are financial incentives to build Passivhaus design	5	-	0.435		-1.508	1.073
2	2. Passivhaus buildings offer good comfort for occupants	2		2.131		1.226	0.904
29	29. The use of MVHR improves indoor air-quality	29		1.502		0.672	0.830
13	13. The Code for Sustainable Homes is a better standard than	13	-	1.195		-2.024	0.829
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	0.948		-1.760	0.812
8	8. Passivhaus is appropriate for the UK climate	8		1.454		0.776	0.679
14	14. The German name Passivhaus is appropriate for the UK mar	14		0.523		-0.140	0.663
7	7. The UK responds well to the Passivhaus German language pr	7	-	0.521		-1.170	0.648
41	41. UK clients are ready to adopt the Passivhaus standard	41		0.341		-0.183	0.525
32	32. There is a market for Passivhaus designs in the UK	32		1.025		0.576	0.449
36	36. Passivhaus designs are future proof	36		1.299		0.853	0.446
1	1. The Passivhaus standard is well understood in the UK	1	-	0.969		-1.399	0.429
28	28. PHPP is developed well for UK design scenarios	28		0.626		0.234	0.392
6	6. Passivhaus designs are too expensive	6	-	0.101		-0.450	0.349
12	12. The Passivhaus standard is very flexible	12		0.882		0.584	0.299
33	33. Passivhaus designs work well with UK building design aes	33		0.559		0.266	0.293
24	24. Passivhaus buildings have to perform as specified to wor	24		1.113		0.904	0.209
3	3. Passivhaus components are affordable in the UK	3	-	0.433		-0.542	0.109
37	37. Passivhaus buildings are difficult to construct	37	-	0.054		-0.151	0.096
25	25. UK current legislation favours Passivhaus design	25	-	0.953		-1.049	0.096
31	31. UK construction types are appropriate for Passivhaus des	31		0.236		0.179	0.057
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.520		-0.575	0.055
4	4. There is a mature supply chain for Passivhaus components	4	-	1.125		-1.085	-0.040
9	9. UK construction skills are appropriate to build Passivhau	9	-	0.657		-0.535	-0.122
11	11. SAP is a more appropriate software for low energy buildi	11	-	1.576		-1.430	-0.146
27	27. Our planning system supports the Passivhaus standard wel	27	-	0.687		-0.528	-0.159

40	40. There is a good communication between different members	40	-	0.383
		-0.188	-0.195	
42	42. The Passivhaus standard is appropriate for new and refur	42		1.203
		1.432	-0.229	
23	23. The UK construction industry has a fast-buck mentality	23		1.020
		1.284	-0.264	
35	35. The UK has a lack of ambition when it comes to building	35		0.694
		0.962	-0.267	
26	26. MVHR uses more energy than it saves	26	-	1.346
		-1.048	-0.298	
21	21. People associate low energy building performance with on	21		1.112
		1.461	-0.350	
10	10. UK design skills are appropriate to design Passivhaus de	10	-	0.499
		-0.074	-0.426	
34	34. People in the UK are frightened by the high degree of ai	34		1.251
		1.709	-0.458	
20	20. The UK Government only looks to BRE to develop building	20		0.386
		0.890	-0.505	
18	18. Passivhaus buildings are restrictive for occupants	18	-	0.975
		-0.446	-0.529	
39	39. In the UK there is a good communication between construc	39	-	0.915
		-0.379	-0.536	
19	19. The Passivhaus standard will only catch on if the major	19		0.450
		1.141	-0.691	
17	17. The materials used to construct Passivhaus designs have	17	-	0.984
		-0.116	-0.868	
30	30. We understand how to detail buildings well in the UK	30	-	1.255
		-0.294	-0.961	
43	43. The Passivhaus standard needs strong and coherent repres	43		1.254
		2.251	-0.998	
16	16. We understand building fabric performance well in the UK	16	-	1.270
		-0.231	-1.039	
38	38. We understand building energy performance well in the UK	38	-	1.258
		-0.096	-1.162	

Descending Array of Differences Between Factors 1 and 5

No.	Statement	No.	Type
1	Type 5 Difference		

Descending Array of Differences Between Factors 2 and 3

No.	Statement	No.	Type 2	Type 3	Difference
38	38. We understand building energy performance well in the UK	38			
1.508				-0.397	1.905
27	27. Our planning system supports the Passivhaus standard wel	27	-		
0.186				-1.893	1.707
30	30. We understand how to detail buildings well in the UK	30			
1.127				-0.250	1.377
40	40. There is a good communication between different members	40			
1.014				-0.168	1.181
39	39. In the UK there is a good communication between construc	39			
0.280				-0.848	1.129
16	16. We understand building fabric performance well in the UK	16			
0.999				0.025	0.974
24	24. Passivhaus buildings have to perform as specified to wor	24			
1.816				0.884	0.933
13	13. The Code for Sustainable Homes is a better standard than	13	-		
0.030				-0.892	0.862
26	26. MVHR uses more energy than it saves	26	-		
0.203				-1.030	0.827
9	9. UK construction skills are appropriate to build Passivhau	9			
0.455				-0.322	0.777
42	42. The Passivhaus standard is appropriate for new and refur	42			
1.015				0.321	0.694
11	11. SAP is a more appropriate software for low energy buildi	11	-		
0.502				-1.188	0.687
6	6. Passivhaus designs are too expensive	6			
0.196				-0.463	0.658
37	37. Passivhaus buildings are difficult to construct	37	-		
0.152				-0.783	0.631
2	2. Passivhaus buildings offer good comfort for occupants	2			
1.972				1.429	0.542
1	1. The Passivhaus standard is well understood in the UK	1	-		
0.889				-1.258	0.368
17	17. The materials used to construct Passivhaus designs have	17			
0.150				-0.048	0.198
32	32. There is a market for Passivhaus designs in the UK	32			
1.203				1.030	0.173
33	33. Passivhaus designs work well with UK building design aes	33			
0.516				0.351	0.165
41	41. UK clients are ready to adopt the Passivhaus standard	41	-		
0.553				-0.611	0.058
5	5. There are financial incentives to build Passivhaus design	5	-		
0.851				-0.871	0.020
8	8. Passivhaus is appropriate for the UK climate	8			
0.915				0.909	0.006
3	3. Passivhaus components are affordable in the UK	3	-		
0.444				-0.449	0.005
29	29. The use of MVHR improves indoor air-quality	29			
0.975				1.080	-0.105
22	22. UK procurement methods work well to deliver Passivhaus d	22	-		
0.979				-0.868	-0.111
10	10. UK design skills are appropriate to design Passivhaus de	10			
0.190				0.308	-0.118

25	25. UK current legislation favours Passivhaus design	25	-1.371	-1.200	-0.171
36	36. Passivhaus designs are future proof	36	1.213	1.403	-0.190
18	18. Passivhaus buildings are restrictive for occupants	18	-1.262	-0.965	-0.296
14	14. The German name Passivhaus is appropriate for the UK mar	14	-0.587	-0.096	-0.491
4	4. There is a mature supply chain for Passivhaus components	4	-1.666	-1.169	-0.497
7	7. The UK responds well to the Passivhaus German language pr	7	-1.195	-0.658	-0.537
28	28. PHPP is developed well for UK design scenarios	28	-0.318	0.268	-0.587
20	20. The UK Government only looks to BRE to develop building	20	-0.484	0.142	-0.626
34	34. People in the UK are frightened by the high degree of ai	34	-0.423	0.304	-0.727
19	19. The Passivhaus standard will only catch on if the major	19	0.621	1.459	-0.838
43	43. The Passivhaus standard needs strong and coherent repres	43	1.099	2.017	-0.917
31	31. UK construction types are appropriate for Passivhaus des	31	-0.999	-0.048	-0.951
15	15. The UK has many existing Passivhaus buildings to learn f	15	-2.294	-1.178	-1.116
21	21. People associate low energy building performance with on	21	0.276	1.397	-1.121
12	12. The Passivhaus standard is very flexible	12	-0.977	0.597	-1.574
23	23. The UK construction industry has a fast-buck mentality	23	0.255	2.176	-1.922
35	35. The UK has a lack of ambition when it comes to building	35	-1.430	1.553	-2.983

Descending Array of Differences Between Factors 2 and 3

No.	Statement	No.	Type 2	Type 3	Difference

Descending Array of Differences Between Factors 2 and 4

No.	Statement	No.	Type	2	Type	4	Difference
9	9. UK construction skills are appropriate to build Passivhau	9		0.455		-1.975	2.430
30	30. We understand how to detail buildings well in the UK	30		1.127		-1.071	2.198
40	40. There is a good communication between different members	40		1.014		-1.067	2.080
38	38. We understand building energy performance well in the UK	38		1.508		-0.136	1.644
39	39. In the UK there is a good communication between construc	39		0.280		-1.179	1.460
16	16. We understand building fabric performance well in the UK	16		0.999		-0.408	1.407
10	10. UK design skills are appropriate to design Passivhaus de	10		0.190		-0.646	0.836
27	27. Our planning system supports the Passivhaus standard wel	27	-	0.186		-0.740	0.554
1	1. The Passivhaus standard is well understood in the UK	1	-	0.889		-1.424	0.535
36	36. Passivhaus designs are future proof	36		1.213		0.697	0.516
13	13. The Code for Sustainable Homes is a better standard than	13	-	0.030		-0.506	0.475
17	17. The materials used to construct Passivhaus designs have	17		0.150		-0.324	0.474
24	24. Passivhaus buildings have to perform as specified to wor	24		1.816		1.378	0.439
29	29. The use of MVHR improves indoor air-quality	29		0.975		0.573	0.402
2	2. Passivhaus buildings offer good comfort for occupants	2		1.972		1.575	0.397
3	3. Passivhaus components are affordable in the UK	3	-	0.444		-0.818	0.374
33	33. Passivhaus designs work well with UK building design aes	33		0.516		0.219	0.297
26	26. MVHR uses more energy than it saves	26	-	0.203		-0.449	0.246
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.979		-1.181	0.201
11	11. SAP is a more appropriate software for low energy buildi	11	-	0.502		-0.687	0.185
5	5. There are financial incentives to build Passivhaus design	5	-	0.851		-1.034	0.183
32	32. There is a market for Passivhaus designs in the UK	32		1.203		1.063	0.140
6	6. Passivhaus designs are too expensive	6		0.196		0.403	-0.207
8	8. Passivhaus is appropriate for the UK climate	8		0.915		1.280	-0.366
42	42. The Passivhaus standard is appropriate for new and refur	42		1.015		1.391	-0.375
41	41. UK clients are ready to adopt the Passivhaus standard	41	-	0.553		-0.176	-0.377

4	4. There is a mature supply chain for Passivhaus components	4	-	1.666	-1.235	-0.431
19	19. The Passivhaus standard will only catch on if the major	19		0.621	1.057	-0.436
20	20. The UK Government only looks to BRE to develop building	20	-	0.484	0.001	-0.486
28	28. PHPP is developed well for UK design scenarios	28	-	0.318	0.179	-0.498
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	2.294	-1.685	-0.609
43	43. The Passivhaus standard needs strong and coherent repres	43		1.099	1.711	-0.612
37	37. Passivhaus buildings are difficult to construct	37	-	0.152	0.514	-0.666
7	7. The UK responds well to the Passivhaus German language pr	7	-	1.195	-0.429	-0.767
12	12. The Passivhaus standard is very flexible	12	-	0.977	-0.155	-0.822
31	31. UK construction types are appropriate for Passivhaus des	31	-	0.999	-0.025	-0.974
25	25. UK current legislation favours Passivhaus design	25	-	1.371	-0.378	-0.993
18	18. Passivhaus buildings are restrictive for occupants	18	-	1.262	-0.189	-1.073
21	21. People associate low energy building performance with on	21		0.276	1.551	-1.275
14	14. The German name Passivhaus is appropriate for the UK mar	14	-	0.587	0.694	-1.281
23	23. The UK construction industry has a fast-buck mentality	23		0.255	1.556	-1.301
34	34. People in the UK are frightened by the high degree of ai	34	-	0.423	1.480	-1.902
35	35. The UK has a lack of ambition when it comes to building	35	-	1.430	0.595	-2.025

Descending Array of Differences Between Factors 2 and 4

No.	Statement	No.	Type
2	Type 4 Difference		

Descending Array of Differences Between Factors 2 and 5

No.	Statement	No.	Type	2	Type	5	Difference
13	13. The Code for Sustainable Homes is a better standard than	13	-	0.030		-2.024	1.993
38	38. We understand building energy performance well in the UK	38		1.508		-0.096	1.604
30	30. We understand how to detail buildings well in the UK	30		1.127		-0.294	1.421
16	16. We understand building fabric performance well in the UK	16		0.999		-0.231	1.230
40	40. There is a good communication between different members	40		1.014		-0.188	1.201
9	9. UK construction skills are appropriate to build Passivhau	9		0.455		-0.535	0.990
11	11. SAP is a more appropriate software for low energy buildi	11	-	0.502		-1.430	0.928
24	24. Passivhaus buildings have to perform as specified to wor	24		1.816		0.904	0.912
26	26. MVHR uses more energy than it saves	26	-	0.203		-1.048	0.846
2	2. Passivhaus buildings offer good comfort for occupants	2		1.972		1.226	0.745
39	39. In the UK there is a good communication between construc	39		0.280		-0.379	0.660
5	5. There are financial incentives to build Passivhaus design	5	-	0.851		-1.508	0.657
6	6. Passivhaus designs are too expensive	6		0.196		-0.450	0.646
32	32. There is a market for Passivhaus designs in the UK	32		1.203		0.576	0.627
1	1. The Passivhaus standard is well understood in the UK	1	-	0.889		-1.399	0.510
36	36. Passivhaus designs are future proof	36		1.213		0.853	0.360
27	27. Our planning system supports the Passivhaus standard wel	27	-	0.186		-0.528	0.342
29	29. The use of MVHR improves indoor air-quality	29		0.975		0.672	0.303
17	17. The materials used to construct Passivhaus designs have	17		0.150		-0.116	0.266
10	10. UK design skills are appropriate to design Passivhaus de	10		0.190		-0.074	0.264
33	33. Passivhaus designs work well with UK building design aes	33		0.516		0.266	0.250
8	8. Passivhaus is appropriate for the UK climate	8		0.915		0.776	0.139
3	3. Passivhaus components are affordable in the UK	3	-	0.444		-0.542	0.098
37	37. Passivhaus buildings are difficult to construct	37	-	0.152		-0.151	-0.002
7	7. The UK responds well to the Passivhaus German language pr	7	-	1.195		-1.170	-0.025
25	25. UK current legislation favours Passivhaus design	25	-	1.371		-1.049	-0.322

41	41. UK clients are ready to adopt the Passivhaus standard	41	-0.553	-0.183	-0.370
22	22. UK procurement methods work well to deliver Passivhaus d	22	-0.979	-0.575	-0.404
42	42. The Passivhaus standard is appropriate for new and refur	42	1.015	1.432	-0.417
14	14. The German name Passivhaus is appropriate for the UK mar	14	-0.587	-0.140	-0.447
19	19. The Passivhaus standard will only catch on if the major	19	0.621	1.141	-0.520
15	15. The UK has many existing Passivhaus buildings to learn f	15	-2.294	-1.760	-0.534
28	28. PHPP is developed well for UK design scenarios	28	-0.318	0.234	-0.552
4	4. There is a mature supply chain for Passivhaus components	4	-1.666	-1.085	-0.581
18	18. Passivhaus buildings are restrictive for occupants	18	-1.262	-0.446	-0.816
23	23. The UK construction industry has a fast-buck mentality	23	0.255	1.284	-1.029
43	43. The Passivhaus standard needs strong and coherent repres	43	1.099	2.251	-1.152
31	31. UK construction types are appropriate for Passivhaus des	31	-0.999	0.179	-1.178
21	21. People associate low energy building performance with on	21	0.276	1.461	-1.185
20	20. The UK Government only looks to BRE to develop building	20	-0.484	0.890	-1.374
12	12. The Passivhaus standard is very flexible	12	-0.977	0.584	-1.560
34	34. People in the UK are frightened by the high degree of ai	34	-0.423	1.709	-2.132
35	35. The UK has a lack of ambition when it comes to building	35	-1.430	0.962	-2.391

Descending Array of Differences Between Factors 2 and 5

No.	Statement	No.	Type

2 Type 5 Difference

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Descending Array of Differences Between Factors 3 and 4

No.	Statement	No.	Type	3 Type	4 Difference
9	9. UK construction skills are appropriate to build Passivhau	9	-	0.322	-1.975	1.653
35	35. The UK has a lack of ambition when it comes to building	35		1.553	0.595	0.958
10	10. UK design skills are appropriate to design Passivhaus de	10		0.308	-0.646	0.955
40	40. There is a good communication between different members	40	-	0.168	-1.067	0.899
30	30. We understand how to detail buildings well in the UK	30	-	0.250	-1.071	0.821
12	12. The Passivhaus standard is very flexible	12		0.597	-0.155	0.752
36	36. Passivhaus designs are future proof	36		1.403	0.697	0.706
23	23. The UK construction industry has a fast-buck mentality	23		2.176	1.556	0.621
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	1.178	-1.685	0.507
29	29. The use of MVHR improves indoor air-quality	29		1.080	0.573	0.507
16	16. We understand building fabric performance well in the UK	16		0.025	-0.408	0.432
19	19. The Passivhaus standard will only catch on if the major	19		1.459	1.057	0.402
3	3. Passivhaus components are affordable in the UK	3	-	0.449	-0.818	0.369
39	39. In the UK there is a good communication between construc	39	-	0.848	-1.179	0.331
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	0.868	-1.181	0.312
43	43. The Passivhaus standard needs strong and coherent repres	43		2.017	1.711	0.306
17	17. The materials used to construct Passivhaus designs have	17	-	0.048	-0.324	0.276
1	1. The Passivhaus standard is well understood in the UK	1	-	1.258	-1.424	0.166
5	5. There are financial incentives to build Passivhaus design	5	-	0.871	-1.034	0.163
20	20. The UK Government only looks to BRE to develop building	20		0.142	0.001	0.141
33	33. Passivhaus designs work well with UK building design aes	33		0.351	0.219	0.132
28	28. PHPP is developed well for UK design scenarios	28		0.268	0.179	0.089
4	4. There is a mature supply chain for Passivhaus components	4	-	1.169	-1.235	0.066
31	31. UK construction types are appropriate for Passivhaus des	31	-	0.048	-0.025	-0.023
32	32. There is a market for Passivhaus designs in the UK	32		1.030	1.063	-0.033
2	2. Passivhaus buildings offer good comfort for occupants	2		1.429	1.575	-0.145

21	21. People associate low energy building performance with on	21	1.397	1.551	-0.154
7	7. The UK responds well to the Passivhaus German language pr	7	0.658	-0.429	-0.230
38	38. We understand building energy performance well in the UK	38	0.397	-0.136	-0.261
8	8. Passivhaus is appropriate for the UK climate	8	0.909	1.280	-0.372
13	13. The Code for Sustainable Homes is a better standard than	13	0.892	-0.506	-0.386
41	41. UK clients are ready to adopt the Passivhaus standard	41	0.611	-0.176	-0.435
24	24. Passivhaus buildings have to perform as specified to wor	24	0.884	1.378	-0.494
11	11. SAP is a more appropriate software for low energy buildi	11	1.188	-0.687	-0.501
26	26. MVHR uses more energy than it saves	26	1.030	-0.449	-0.581
18	18. Passivhaus buildings are restrictive for occupants	18	0.965	-0.189	-0.776
14	14. The German name Passivhaus is appropriate for the UK mar	14	0.096	0.694	-0.790
25	25. UK current legislation favours Passivhaus design	25	1.200	-0.378	-0.821
6	6. Passivhaus designs are too expensive	6	0.463	0.403	-0.866
42	42. The Passivhaus standard is appropriate for new and refur	42	0.321	1.391	-1.070
27	27. Our planning system supports the Passivhaus standard wel	27	1.893	-0.740	-1.153
34	34. People in the UK are frightened by the high degree of ai	34	0.304	1.480	-1.175
37	37. Passivhaus buildings are difficult to construct	37	0.783	0.514	-1.297

Descending Array of Differences Between Factors 3 and 4

No.	Statement	No.	Type 3	Type 4	Difference

Descending Array of Differences Between Factors 3 and 5

No.	Statement	No.	Type	3 Type	5 Difference
13	13. The Code for Sustainable Homes is a better standard than	13	-	0.892	-2.024 1.132
23	23. The UK construction industry has a fast-buck mentality	23		2.176	1.284 0.892
5	5. There are financial incentives to build Passivhaus design	5	-	0.871	-1.508 0.637
35	35. The UK has a lack of ambition when it comes to building	35		1.553	0.962 0.592
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	1.178	-1.760 0.582
36	36. Passivhaus designs are future proof	36		1.403	0.853 0.550
7	7. The UK responds well to the Passivhaus German language pr	7	-	0.658	-1.170 0.512
32	32. There is a market for Passivhaus designs in the UK	32		1.030	0.576 0.454
29	29. The use of MVHR improves indoor air-quality	29		1.080	0.672 0.408
10	10. UK design skills are appropriate to design Passivhaus de	10		0.308	-0.074 0.382
19	19. The Passivhaus standard will only catch on if the major	19		1.459	1.141 0.319
16	16. We understand building fabric performance well in the UK	16		0.025	-0.231 0.256
11	11. SAP is a more appropriate software for low energy buildi	11	-	1.188	-1.430 0.241
9	9. UK construction skills are appropriate to build Passivhau	9	-	0.322	-0.535 0.213
2	2. Passivhaus buildings offer good comfort for occupants	2		1.429	1.226 0.203
1	1. The Passivhaus standard is well understood in the UK	1	-	1.258	-1.399 0.141
8	8. Passivhaus is appropriate for the UK climate	8		0.909	0.776 0.133
3	3. Passivhaus components are affordable in the UK	3	-	0.449	-0.542 0.093
33	33. Passivhaus designs work well with UK building design aes	33		0.351	0.266 0.085
17	17. The materials used to construct Passivhaus designs have	17	-	0.048	-0.116 0.068
14	14. The German name Passivhaus is appropriate for the UK mar	14	-	0.096	-0.140 0.044
30	30. We understand how to detail buildings well in the UK	30	-	0.250	-0.294 0.044
28	28. PHPP is developed well for UK design scenarios	28		0.268	0.234 0.035
40	40. There is a good communication between different members	40	-	0.168	-0.188 0.020
26	26. MVHR uses more energy than it saves	26	-	1.030	-1.048 0.019
12	12. The Passivhaus standard is very flexible	12		0.597	0.584 0.013

6	6. Passivhaus designs are too expensive	6	-	
0.463	-0.450	-0.012		
24	24. Passivhaus buildings have to perform as specified to wor	24		
0.884	0.904	-0.020		
21	21. People associate low energy building performance with on	21		
1.397	1.461	-0.064		
4	4. There is a mature supply chain for Passivhaus components	4	-	
1.169	-1.085	-0.084		
25	25. UK current legislation favours Passivhaus design	25	-	
1.200	-1.049	-0.151		
31	31. UK construction types are appropriate for Passivhaus des	31	-	
0.048	0.179	-0.227		
43	43. The Passivhaus standard needs strong and coherent repres	43		
2.017	2.251	-0.234		
22	22. UK procurement methods work well to deliver Passivhaus d	22	-	
0.868	-0.575	-0.293		
38	38. We understand building energy performance well in the UK	38	-	
0.397	-0.096	-0.301		
41	41. UK clients are ready to adopt the Passivhaus standard	41	-	
0.611	-0.183	-0.428		
39	39. In the UK there is a good communication between construc	39	-	
0.848	-0.379	-0.469		
18	18. Passivhaus buildings are restrictive for occupants	18	-	
0.965	-0.446	-0.520		
37	37. Passivhaus buildings are difficult to construct	37	-	
0.783	-0.151	-0.633		
20	20. The UK Government only looks to BRE to develop building	20		
0.142	0.890	-0.748		
42	42. The Passivhaus standard is appropriate for new and refur	42		
0.321	1.432	-1.111		
27	27. Our planning system supports the Passivhaus standard wel	27	-	
1.893	-0.528	-1.366		
34	34. People in the UK are frightened by the high degree of ai	34		
0.304	1.709	-1.405		

Descending Array of Differences Between Factors 3 and 5

No.	Statement	No.	Type 3	Type 5	Difference

Descending Array of Differences Between Factors 4 and 5

No.	Statement	No.	Type	4	Type	5	Difference
13	13. The Code for Sustainable Homes is a better standard than	13	-	0.506		-2.024	1.518
6	6. Passivhaus designs are too expensive	6		0.403		-0.450	0.853
14	14. The German name Passivhaus is appropriate for the UK mar	14		0.694		-0.140	0.834
11	11. SAP is a more appropriate software for low energy buildi	11	-	0.687		-1.430	0.743
7	7. The UK responds well to the Passivhaus German language pr	7	-	0.429		-1.170	0.741
25	25. UK current legislation favours Passivhaus design	25	-	0.378		-1.049	0.670
37	37. Passivhaus buildings are difficult to construct	37		0.514		-0.151	0.664
26	26. MVHR uses more energy than it saves	26	-	0.449		-1.048	0.600
8	8. Passivhaus is appropriate for the UK climate	8		1.280		0.776	0.505
32	32. There is a market for Passivhaus designs in the UK	32		1.063		0.576	0.487
5	5. There are financial incentives to build Passivhaus design	5	-	1.034		-1.508	0.474
24	24. Passivhaus buildings have to perform as specified to wor	24		1.378		0.904	0.474
2	2. Passivhaus buildings offer good comfort for occupants	2		1.575		1.226	0.348
23	23. The UK construction industry has a fast-buck mentality	23		1.556		1.284	0.272
18	18. Passivhaus buildings are restrictive for occupants	18	-	0.189		-0.446	0.257
21	21. People associate low energy building performance with on	21		1.551		1.461	0.090
15	15. The UK has many existing Passivhaus buildings to learn f	15	-	1.685		-1.760	0.075
41	41. UK clients are ready to adopt the Passivhaus standard	41	-	0.176		-0.183	0.007
1	1. The Passivhaus standard is well understood in the UK	1	-	1.424		-1.399	-0.025
38	38. We understand building energy performance well in the UK	38	-	0.136		-0.096	-0.040
42	42. The Passivhaus standard is appropriate for new and refur	42		1.391		1.432	-0.041
33	33. Passivhaus designs work well with UK building design aes	33		0.219		0.266	-0.047
28	28. PHPP is developed well for UK design scenarios	28		0.179		0.234	-0.054
19	19. The Passivhaus standard will only catch on if the major	19		1.057		1.141	-0.084
29	29. The use of MVHR improves indoor air-quality	29		0.573		0.672	-0.099
4	4. There is a mature supply chain for Passivhaus components	4	-	1.235		-1.085	-0.150

36	36. Passivhaus designs are future proof	36	0.697	0.853	-0.156
16	16. We understand building fabric performance well in the UK	16	0.408	-0.231	-0.177
31	31. UK construction types are appropriate for Passivhaus des	31	0.025	0.179	-0.204
17	17. The materials used to construct Passivhaus designs have	17	0.324	-0.116	-0.208
27	27. Our planning system supports the Passivhaus standard wel	27	0.740	-0.528	-0.212
34	34. People in the UK are frightened by the high degree of ai	34	1.480	1.709	-0.230
3	3. Passivhaus components are affordable in the UK	3	0.818	-0.542	-0.276
35	35. The UK has a lack of ambition when it comes to building	35	0.595	0.962	-0.366
43	43. The Passivhaus standard needs strong and coherent repres	43	1.711	2.251	-0.540
10	10. UK design skills are appropriate to design Passivhaus de	10	0.646	-0.074	-0.573
22	22. UK procurement methods work well to deliver Passivhaus d	22	1.181	-0.575	-0.606
12	12. The Passivhaus standard is very flexible	12	0.155	0.584	-0.739
30	30. We understand how to detail buildings well in the UK	30	1.071	-0.294	-0.777
39	39. In the UK there is a good communication between construc	39	1.179	-0.379	-0.800
40	40. There is a good communication between different members	40	1.067	-0.188	-0.879
20	20. The UK Government only looks to BRE to develop building	20	0.001	0.890	-0.889
9	9. UK construction skills are appropriate to build Passivhau	9	1.975	-0.535	-1.440

Descending Array of Differences Between Factors 4 and 5

No.	Statement	No. 4 Type	No. 5 Type	Difference

Path and Project Name: C:\PQMETHOD\PROJECTS/summerpa
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Factor Q-Sort Values for Each Statement

Factor Arrays

No.	Statement	No.	1	2	3	4	5
1	1. The Passivhaus standard is well understood in the UK	1	-2	-2	-4	-4	-3
2	2. Passivhaus buildings offer good comfort for occupants	2	5	5	3	4	3
3	3. Passivhaus components are affordable in the UK	3	0	-1	-1	-2	-2
4	4. There is a mature supply chain for Passivhaus components	4	-3	-4	-3	-3	-3
5	5. There are financial incentives to build Passivhaus design	5	0	-2	-2	-2	-4
6	6. Passivhaus designs are too expensive	6	0	0	-1	1	-1
7	7. The UK responds well to the Passivhaus German language pr	7	-1	-3	-1	-1	-3
8	8. Passivhaus is appropriate for the UK climate	8	4	2	2	2	2
9	9. UK construction skills are appropriate to build Passivhau	9	-1	1	0	-5	-2
10	10. UK design skills are appropriate to design Passivhaus de	10	-1	0	1	-1	0
11	11. SAP is a more appropriate software for low energy buildi	11	-5	-1	-3	-2	-3
12	12. The Passivhaus standard is very flexible	12	2	-2	2	0	1
13	13. The Code for Sustainable Homes is a better standard than	13	-3	0	-2	-1	-5
14	14. The German name Passivhaus is appropriate for the UK mar	14	1	-2	0	2	0
15	15. The UK has many existing Passivhaus buildings to learn f	15	-2	-5	-3	-4	-4
16	16. We understand building fabric performance well in the UK	16	-4	2	0	-1	-1
17	17. The materials used to construct Passivhaus designs have	17	-2	0	0	0	0
18	18. Passivhaus buildings are restrictive for occupants	18	-2	-3	-2	0	-1
19	19. The Passivhaus standard will only catch on if the major	19	1	1	3	2	3
20	20. The UK Government only looks to BRE to develop building	20	1	-1	1	0	2
21	21. People associate low energy building performance with on	21	2	1	3	3	4
22	22. UK procurement methods work well to deliver Passivhaus d	22	-1	-2	-2	-3	-2
23	23. The UK construction industry has a fast-buck mentality	23	2	1	5	4	3
24	24. Passivhaus buildings have to perform as specified to wor	24	2	4	2	3	2
25	25. UK current legislation favours Passivhaus design	25	-2	-3	-4	-1	-2

26	26. MVHR uses more energy than it saves	26	-4	0	-3	-1	-2
27	27. Our planning system supports the Passivhaus standard wel	27	-1	0	-5	-2	-1
28	28. PHPP is developed well for UK design scenarios	28	1	-1	1	1	1
29	29. The use of MVHR improves indoor air-quality	29	4	2	2	1	1
30	30. We understand how to detail buildings well in the UK	30	-3	3	0	-3	-1
31	31. UK construction types are appropriate for Passivhaus des	31	0	-3	0	0	1
32	32. There is a market for Passivhaus designs in the UK	32	2	3	2	2	1
33	33. Passivhaus designs work well with UK building design aes	33	1	1	1	1	1
34	34. People in the UK are frightened by the high degree of ai	34	3	-1	1	3	4
35	35. The UK has a lack of ambition when it comes to building	35	1	-4	4	1	2
36	36. Passivhaus designs are future proof	36	3	3	3	2	2
37	37. Passivhaus buildings are difficult to construct	37	0	0	-1	1	0
38	38. We understand building energy performance well in the UK	38	-3	4	-1	0	0
39	39. In the UK there is a good communication between construc	39	-1	1	-2	-3	-1
40	40. There is a good communication between different members	40	0	2	0	-2	0
41	41. UK clients are ready to adopt the Passivhaus standard	41	0	-1	-1	0	0
42	42. The Passivhaus standard is appropriate for new and refur	42	3	2	1	3	3
43	43. The Passivhaus standard needs strong and coherent repres	43	3	3	4	5	5

Variance = 5.535 St. Dev. = 2.353

Path and Project Name: C:\PQMETHOD\PROJECTS/summerpa
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Factor Q-Sort Values for Statements sorted by Consensus vs. Disagreement
(Variance across normalized Factor Scores)

Factor Arrays

No.	Statement	No.	1	2	3	4	5
33	33. Passivhaus designs work well with UK building design aes	33	1	1	1	1	1
3	3. Passivhaus components are affordable in the UK	3	0	-1	-1	-2	-2
4	4. There is a mature supply chain for Passivhaus components	4	-3	-4	-3	-3	-3
32	32. There is a market for Passivhaus designs in the UK	32	2	3	2	2	1
1	1. The Passivhaus standard is well understood in the UK	1	-2	-2	-4	-4	-3
22	22. UK procurement methods work well to deliver Passivhaus d	22	-1	-2	-2	-3	-2
8	8. Passivhaus is appropriate for the UK climate	8	4	2	2	2	2
36	36. Passivhaus designs are future proof	36	3	3	3	2	2
28	28. PHPP is developed well for UK design scenarios	28	1	-1	1	1	1
7	7. The UK responds well to the Passivhaus German language pr	7	-1	-3	-1	-1	-3
29	29. The use of MVHR improves indoor air-quality	29	4	2	2	1	1
2	2. Passivhaus buildings offer good comfort for occupants	2	5	5	3	4	3
25	25. UK current legislation favours Passivhaus design	25	-2	-3	-4	-1	-2
41	41. UK clients are ready to adopt the Passivhaus standard	41	0	-1	-1	0	0
6	6. Passivhaus designs are too expensive	6	0	0	-1	1	-1
5	5. There are financial incentives to build Passivhaus design	5	0	-2	-2	-2	-4
24	24. Passivhaus buildings have to perform as specified to wor	24	2	4	2	3	2
19	19. The Passivhaus standard will only catch on if the major	19	1	1	3	2	3
10	10. UK design skills are appropriate to design Passivhaus de	10	-1	0	1	-1	0
17	17. The materials used to construct Passivhaus designs have	17	-2	0	0	0	0
18	18. Passivhaus buildings are restrictive for occupants	18	-2	-3	-2	0	-1
42	42. The Passivhaus standard is appropriate for new and refur	42	3	2	1	3	3
37	37. Passivhaus buildings are difficult to construct	37	0	0	-1	1	0
11	11. SAP is a more appropriate software for low energy buildi	11	-5	-1	-3	-2	-3
26	26. MVHR uses more energy than it saves	26	-4	0	-3	-1	-2

43	43. The Passivhaus standard needs strong and coherent repres	43	3	3	4	5	5
31	31. UK construction types are appropriate for Passivhaus des	31	0	-3	0	0	1
20	20. The UK Government only looks to BRE to develop building	20	1	-1	1	0	2
21	21. People associate low energy building performance with on	21	2	1	3	3	4
14	14. The German name Passivhaus is appropriate for the UK mar	14	1	-2	0	2	0
15	15. The UK has many existing Passivhaus buildings to learn f	15	-2	-5	-3	-4	-4
39	39. In the UK there is a good communication between construc	39	-1	1	-2	-3	-1
27	27. Our planning system supports the Passivhaus standard wel	27	-1	0	-5	-2	-1
23	23. The UK construction industry has a fast-buck mentality	23	2	1	5	4	3
40	40. There is a good communication between different members	40	0	2	0	-2	0
13	13. The Code for Sustainable Homes is a better standard than	13	-3	0	-2	-1	-5
12	12. The Passivhaus standard is very flexible	12	2	-2	2	0	1
16	16. We understand building fabric performance well in the UK	16	-4	2	0	-1	-1
9	9. UK construction skills are appropriate to build Passivhau	9	-1	1	0	-5	-2
34	34. People in the UK are frightened by the high degree of ai	34	3	-1	1	3	4
30	30. We understand how to detail buildings well in the UK	30	-3	3	0	-3	-1
38	38. We understand building energy performance well in the UK	38	-3	4	-1	0	0
35	35. The UK has a lack of ambition when it comes to building	35	1	-4	4	1	2

Factor Characteristics

	Factors				
	1	2	3	4	5
No. of Defining Variables	30	4	10	20	7
Average Rel. Coef.	0.800	0.800	0.800	0.800	0.800
Composite Reliability	0.992	0.941	0.976	0.988	0.966
S.E. of Factor Scores	0.091	0.243	0.156	0.111	0.186

Standard Errors for Differences in Normalized Factor Scores

(Diagonal Entries Are S.E. Within Factors)

Factors	1	2	3	4	5
1	0.129	0.259	0.181	0.144	0.207
2	0.259	0.343	0.288	0.267	0.305
3	0.181	0.288	0.221	0.192	0.243
4	0.144	0.267	0.192	0.157	0.216
5	0.207	0.305	0.243	0.216	0.263

Distinguishing Statements for Factor 1

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value and the Normalized Score are Shown.

			Factors								
			1		2		3		4		5
No.	Statement	No.	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK SCORE
29	29. The use of MVHR im ...	29	4	1.50	2	0.97	2	1.08	1	0.57	1 0.67
41	41. UK clients are rea ...	41	0	0.34	-1	-0.55	-1	-0.61	0	-0.18	0 -0.18
17	17. The materials used ...	17	-2	-0.98*	0	0.15	0	-0.05	0	-0.32	0 -0.12
38	38. We understand buil ...	38	-3	-1.26*	4	1.51	-1	-0.40	0	-0.14	0 -0.10
16	16. We understand buil ...	16	-4	-1.27*	2	1.00	0	0.02	-1	-0.41	-1 -0.23

Distinguishing Statements for Factor 2

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value and the Normalized Score are Shown.

			Factors								
			1		2		3		4		5
No.	Statement	No.	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK SCORE
38	38. We understand buil ...	38	-3	-1.26	4	1.51*	-1	-0.40	0	-0.14	0 -0.10
30	30. We understand how ...	30	-3	-1.26	3	1.13*	0	-0.25	-3	-1.07	-1 -0.29
40	40. There is a good co ...	40	0	-0.38	2	1.01*	0	-0.17	-2	-1.07	0 -0.19
16	16. We understand buil ...	16	-4	-1.27	2	1.00*	0	0.02	-1	-0.41	-1 -0.23
9	9. UK construction ski ...	9	-1	-0.66	1	0.46*	0	-0.32	-5	-1.97	-2 -0.53
39	39. In the UK there is ...	39	-1	-0.92	1	0.28	-2	-0.85	-3	-1.18	-1 -0.38
21	21. People associate l ...	21	2	1.11	1	0.28*	3	1.40	3	1.55	4 1.46
23	23. The UK constructio ...	23	2	1.02	1	0.25*	5	2.18	4	1.56	3 1.28
34	34. People in the UK a ...	34	3	1.25	-1	-0.42	1	0.30	3	1.48	4 1.71
12	12. The Passivhaus sta ...	12	2	0.88	-2	-0.98*	2	0.60	0	-0.16	1 0.58

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  31 31. UK construction ty ... 31    0  0.24    -3 -1.00*    0 -0.05     0 -
0.03     1  0.18
  35 35. The UK has a lack  ... 35    1  0.69    -4 -1.43*    4  1.55     1
0.60     2  0.96
```

Distinguishing Statements for Factor 3

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value and the Normalized Score are Shown.

			Factors									
			1		2		3		4		5	
No.	Statement	No.	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE
23	23. The UK constructio ...	23	2	1.02	1	0.25	5	2.18*	4	1.56	3	1.28
35	35. The UK has a lack ...	35	1	0.69	-4	-1.43	4	1.55	1	0.60	2	0.96
42	42. The Passivhaus sta ...	42	3	1.20	2	1.02	1	0.32	3	1.39	3	1.43
34	34. People in the UK a ...	34	3	1.25	-1	-0.42	1	0.30	3	1.48	4	1.71
37	37. Passivhaus buildin ...	37	0	-0.05	0	-0.15	-1	-0.78	1	0.51	0	-0.15
27	27. Our planning syste ...	27	-1	-0.69	0	-0.19	-5	-1.89*	-2	-0.74	-1	-0.53

Distinguishing Statements for Factor 4

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value and the Normalized Score are Shown.

		Factors								
			1		2		3		4	5
No.	Statement	No.	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE
37	37. Passivhaus buildin ...	37	0	-0.05	0	-0.15	-1	-0.78	1	0.51	0	-0.15
12	12. The Passivhaus sta ...	12	2	0.88	-2	-0.98	2	0.60	0	-0.16*	1	0.58
25	25. UK current legisla ...	25	-2	-0.95	-3	-1.37	-4	-1.20	-1	-0.38*	-2	-1.05
40	40. There is a good co ...	40	0	-0.38	2	1.01	0	-0.17	-2	-1.07*	0	-0.19
9	9. UK construction ski ...	9	-1	-0.66	1	0.46	0	-0.32	-5	-1.97*	-2	-0.53

Distinguishing Statements for Factor 5

(P < .05 ; Asterisk (*) Indicates Significance at P < .01)

Both the Factor Q-Sort Value and the Normalized Score are Shown.

		Factors								
			1		2		3		4	5
No.	Statement	No.	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE
20	20. The UK Government ...	20	1	0.39	-1	-0.48	1	0.14	0	0.00	2	0.89
5	5. There are financial ...	5	0	-0.43	-2	-0.85	-2	-0.87	-2	-1.03	-4	-1.51
13	13. The Code for Susta ...	13	-3	-1.19	0	-0.03	-2	-0.89	-1	-0.51	-5	-2.02*

Consensus Statements -- Those That Do Not Distinguish Between ANY Pair of Factors.

All Listed Statements are Non-Significant at P>.01, and Those Flagged With an * are also Non-Significant at P>.05.

		Factors									
		1		2		3		4		5	
No.	Statement	No.	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK	SCORE	RNK SCORE
4	4. There is a mature s ...	4	-3	-1.12	-4	-1.67	-3	-1.17	-3	-1.24	-3 -1.09
32	32. There is a market ...	32	2	1.02	3	1.20	2	1.03	2	1.06	1 0.58
33	33. Passivhaus designs ...	33	1	0.56	1	0.52	1	0.35	1	0.22	1 0.27

QANALYZE was completet at 11:45:42

Q-Test Interview Respondents

Q-test Respondents – Alphabetical List				
No.	**Interview Code**	**Professional Description**	**Q-test**	**Interview Transcription**
1	A	Passivhaus Consultant	yes	yes
2	B	Engineer/Independent Passivhaus Consultant and Trainer	yes	yes
3	C	Passivhaus Consultant	yes	no permission given to use interview
4	D	Passivhaus Consultant and Architect	yes	yes
5	E	Architect/Certified Passivhaus Designer	yes	yes
6	F	Architect/ Designer of early UK Passivhaus Refurbishment	yes	yes
7	G	Architect and Passivhaus Designer of early UK New-build Passivhaus Projects in UK	yes	no – did not give interview
8	H	Architect and Passivhaus Designer	yes	no – did not give interview
9	I	Architect and Passivhaus Designer	yes	no – did not give interview
10	J	Architect and Passivhaus Designer	yes	no – did not give interview
11	K	Architect and Passivhaus Designer	yes	yes
12	L	Architect and Passivhaus Designer	yes	yes
13	M	Architect and Passivhaus Designer	yes	yes
14	N	Architect and Passivhaus Designer	yes	yes
15	O	Architect and Passivhaus Designer	yes	yes
16	P	Architect and Passivhaus Designer	yes	yes
17	Q	Sustainable Design Engineer	yes	yes
18	R	Sustainability Consultant	yes	no – did not give interview
19	S	Sustainability Consultant	yes	yes
20	T	Building Services Engineer	yes	yes
21	U	Engineer	yes	yes
22	V	Engineer	yes	yes
23	W	Engineer/ Passivhaus designer	yes	yes
24	X	Engineer	yes	yes
25	Y	Engineer	yes	yes
26	Z	Passivhaus Client	yes	yes
27	AA	Passivhaus Client /Passivhaus Designer	yes	yes
28	BB	Passivhaus Client	yes	yes
29	CC	Engineer/Higher Education Lecturer	yes	no – did not give interview
30	DD	Architect/Higher Education Lecturer	yes	no – did not give interview

Q-Test Interview Respondents

31	EE	Architect/Higher Education Lecturer in Passivhaus Design	yes	yes
32	FF	Higher Education Lecturer/Architect	yes	yes
33	GG	Higher Education Lecturer/Physicist	yes	yes
34	HH	CSH/Sustainability consultant	yes	no permission given to use interview
35	II	CSH and Passivhaus Consultant	yes	yes
36	JJ	Passivhaus Contractor	yes	yes
37	KK	Passivhaus Contractor	yes	yes
38	LL	London Planner	yes	no – did not give interview
39	MM	London Planner	yes	yes
40	NN	London Planner	yes	yes
41	OO	London Planner	yes	yes
42	PP	Policy Advisor	yes	yes
43	QQ	Policy Advisor	yes	yes
44	RR	Policy Advisor	yes	yes
45	SS	Policy Advisor	yes	yes

Q-Test Interview Respondents

Q-Test Respondents by Profession				
No.	**Interview Code**	**Professional Description**	**Interview Transcription Permission**	**Quotations used in Thesis**
		Architects x 8		
1	E	Architect /Certified Passivhaus Designer	yes	yes
2	F	Architect/Designer of early UK Passivhaus Refurbishment	yes	yes
3	K	Architect and Passivhaus Designer	yes	no
4	L	Architect and Passivhaus Designer	yes	yes
5	M	Architect and Passivhaus Designer	yes	yes
6	N	Architect and Passivhaus Designer	yes	no
7	O	Architect and Passivhaus Designer	yes	no
8	P	Architect and Passivhaus Designer	yes	yes
		Clients x 3		
9	AA	Passivhaus Client /Passivhaus Designer	yes	yes
10	BB	Passivhaus Client	yes	yes
11	Z	Passivhaus Client	yes	no
		Policy Advisors x 4		
12	PP	Policy Advisor	yes	yes
13	QQ	Policy Advisor	yes	yes
14	RR	Policy Advisor	yes	yes
15	SS	Policy Advisor	yes	yes
		Educators x 3		
16	EE	Higher Education Lecturer in Passivhaus Design	yes	yes
17	FF	Higher Education Lecturer/Architect	yes	yes
18	GG	Higher Education Lecturer/Physicist	yes	yes
		Contractors x 2		
19	JJ	Passivhaus Contractor	yes	yes
20	KK	Passivhaus Contractor	yes	no
		Passivhaus/Sustainability Consultants x 4		
21	A	Passivhaus Consultant	yes	yes
22	D	Passivhaus Consultant and Architect	yes	yes
23	II	CSH and Passivhaus Consultant	yes	no
24	S	Sustainability Consultant	yes	no
		Planners x 3		
25	MM	London Planner	yes	no
26	OO	London Planner	yes	yes
27	NN	London Planner	yes	no
		Engineers x 8		

Q-Test Interview Respondents

28	B	Engineer/Independent Passivhaus Consultant and Trainer	yes	yes
29	Q	Sustainable Design Engineer	yes	yes
30	T	Building Services Engineer	yes	yes
31	U	Engineer	yes	yes
32	V	Engineer	yes	no
33	W	Engineer/ Passivhaus designer	yes	no
34	X	Engineer	yes	yes
35	Y	Engineer	yes	yes

Q – Interview Transcriptions – Interviews from Summer 2010

Architects

1.E – Architect / Certified Passivhaus Designer

E – There are some things I want to be more at this end and there are some

Me – you have put as your most favourite or the one that you agree with most is that the UK has a lack of ambition when it comes to building low energy buildings – would you like to say anything more about that

E – I suppose in some respects there is an increased gearing towards developing some kind of increased carbon neutrality for buildings – but there isn't necessarily an understanding of what low energy buildings is – so there are different drivers taking place under those conditions and in that context there is quite poor understanding of what true low energy building is especially when you consider that very many simple decisions can lead to some quite outrageous increases in energy

Me – and this end of the scale (least agree with) you have put we understand building energy performance well in the UK –

E – yes it kind of balances out really – we don't understand low energy buildings at one end – I kind of agree with that and at the other end it is because we don't have an understanding of energy performance

Me – you have also got up at this end that in the UK there is a good communication between construction trades?

E – there isn't good communication at the moment I think – you can forge it you can make it, it's not saying that it doesn't exist but I think that by enlarge the whole procurement process doesn't favour integrated thinking and decision making processes so therefore even now on the scheme that I am working on we have tried to engage with the contractor and we have sat down with them and we have looked at construction details but then that contractor then passes it on to his site manager later on and the site manager goes and questions all those details – sometimes rightly cos those guys the site managers know about the day to day buildability whilst the other construction guy that we have been talking to has been managing things for the last twenty years so again it is getting the appropriate feedback that we were looking for and thought we were getting at the right point in time – so that is the only way that you can start to deliver buildings that will achieve the standards of performance in terms of air-tightness or thermal bridging and everybody why the details are and what they are

Me – how could that be improved?

E – through partnering processes which is something that we do have at the Racecourse scheme so we are already in a very good position compared to many others so I really am talking about how it could be refined further, so maybe getting with the guys who are going to be dealing with on site – getting them to crit the drawings so that you know that these are guys from the site because they have got mud on their shoes things like that – you have got to make sure that you are dealing with the right people at the right stages so perhaps there is more work to do in terms of finding those people and making sure that we get the right input from the right people

Me – also up this end you have got people are frightened by the high degree of air-tightness would you like to say something about your own experience with that?

E – A lot of people seem to think that they will suffocate in a Passivhaus and that it is like living in a plastic bag and it is completely not the case you have got issues whereby the air-tightness is stringent but it isn't at the point where no air is getting into the buildings therefore you can still have a limited amount of fresh air getting in through those leakages which are about equivalent in size to a cat-flap, and then you have got the ventilation heat recovery system which is obviously providing fresh air at all times when it is not switched off and people of course could always open the windows should they chose to do so, yet again there is often mis-understanding that you can't open the windows in a Passivhaus when in fact you can but all that happens is your energy bill gets a little bit bigger

Me – and what about the general spread of statements how do you think they relate to your experiences with Passivhaus design in the UK?

E – they are strongly influenced by my experience and by my perception of outside of my experience shall we say dealing with other people in the office and different discussions with contractors and the perceived more onerous aspects of Passivhaus and the costs associated with that so the way that the spread is divided really ties into my experiences to date

Me – in the center – are there any reasons why you have particularly put these things in the center

E – yeah – construction skills we lack the appropriate construction skills and plasterers don't know how to deliver air-tightness and – some simple decisions about where they stop the plaster but these decisions are not understood so that leads to more onerous conditions and more technological focuses as solutions to problems as opposed to simple skills issues – architects and engineers are very poorly trained at the moment in my view and just knowing the self-learning curve that I had to go on to try and close the gap – I know that my university education fell far far too short and didn't assist me in joining the different dots together and thinking about some of the finer details

Me – where did you study?

E – I studied at Newcastle University which is quite a well-respected technically driven architecture course and this was say ten years ago or so – more than that and when I started the course it had a much higher technical knowledge at that particular point in time and even then but when I started at university Passivhaus wasn't even a standard – so never mind having made that transition in terms of language so there is some huge steps there that have obviously taken place but I think that there needs to be a new wave of understanding of building physics for all engineers and all architects and that does not just include students that includes all those in practice as well there needs to be new fresh initiatives to drive that home – in Canada they had the R2000 standard and that had 30 million dollars of resourcing in 1984 and that has more or less transformed their construction industry up until the point of when the programme shut down the builders were knocking on the door and saying please can you start it and we will pay you to start it up again because they actually got some qualitative benefits from that in terms of to take that out and win work

Me – and they actually went round to existing practices and were retraining the workforce as well as people in university, college or whatever?

E – The focus was people in practice as far as I understand it – I don't know enough about the background of the R2000 training programme but you only catch snippets of it here and there

Me – Is there anything else you would like to say about this overall?

E – A couple of things that are jumping out – I think that PHPP as a design tool is very well suited to development in the UK, though it needs further weather data and there are a couple of gaps in there at the moment but those are gaps that can be filled so it is a minor inhibitor rather than anything else – people's pathology about MVHR – they have concerns about the impact on indoor air-quality – all my research would suggest to date that it is a little bit misguided and it really relates back to much earlier attempts and attempts that have also use humidification kit and that is where you can start to introduce spores, mould and fungi that can cause allergies and poor indoor air-quality – there aren't any financial initiatives in the UK to help promote low energy buildings we have now go these renewable heat incentives for generating heat we have got feed-in tariffs for generating electricity but how about mitigating energy consumption the UK has got no policy for that at all – and given that you can reduce your carbon emissions by using Passivhaus approaches, the mind boggles as to why incentives are not there as well – there should be the renewable non-heat incentive – Passivhaus is a concept that isn't well understood in the UK – it has not received an awful lot of press inches at the moment but there are training courses by the CEPH course that are being delivered by Strathclyde University and the BRE that can assist with both approving and addressing skills and also by word of mouth improving kind of general awareness and then the misconception that MVHR might use more energy than it saves – monitored statistics have shown that some units can have a co-efficient of performance of 10-14

and this is significantly better than you might get out of the average heat pump or something like that so it can definitely save energy and carbon in those contacts – also the standard – the quality assurance methodologies associated with Passivhaus can be used in existing buildings – it might not always be appropriate to apply the 15kWh per metre squared – where in my experience of retrofitting some small domestic units it could be far too onerous a challenge and as for the code for sustainable homes whether it is a better standard than Passivhaus – they are completely different in the gross respect – Passivhaus can tie in quite neatly with the code but the code does look at a broader array of projects but it doesn't really address enough subjects to be truly sustainable and it also includes a lot of perverse incentives that are in doubt – whereas if you went through PHPP to looked at primary energy to produce showers – and rainwater harvesting systems have got parasitic energy loads associated with them which can be higher than the carbon emissions from mains water – so there are certain questions that can be asked about the tool in that way which – so really the argument for Passivhaus is one of a rigour and not only a thing that may be covered by Passivhaus at the moment but there is a certain philosophical approach to the rigour which I think could be widely adopted in the UK to the benefit of the country

Me – why do you think we haven't got that rigour in something like the code?

E – Well we are often based on percentage improvements and percentage improvements relative to what? Relative to 2002 building regulations but that is a random stick in the sand if it was relevant to 1990 Kyoto targets I would start to understand the strength of that data but at the end of the day we consume energy in kilowatt hours our homes are a specific quantity – it is a very specific quantity that we are starting to deal with in the same way that if we have got a tap it has got a flow of water through it at specific pressure and we can measure what that is and how many litres flow it is and we can think of technologies that can reduce that rather than develop calculators that make random assumptions about how often people bathe which we can't control but you can do a lot more demand side management and you need specific ways of thinking that are sufficiently granular to allow that to happen

2.F – Architect/Designer of early UK Passivhaus Refurbishment

Me – I was going to ask you why you have put – particularly to start within the plus five bit up here – why you have put Passivhaus buildings offer good comfort for occupants

F – yup – I think that is because of the surprise from me or the revelation that the kind of experience of being in a house with carbon or tending towards a Passivhaus building is just noticeably different both in winter in terms of lack of drafts and constant feeling of uniform temperature but also buildings I have been to in warmer months to feel equally more – I am at risk of using the word comfort again and again but the rigour of the system that tests the design before it is built almost completely assures that the environmental balance in the house is much more - I guess this is one of the biggest differences when I experienced it for the first few time it made an impression on me I suppose.

Me – have you been to see many finished Passivhaus projects?

F – well not many – the only ones I have seen in the cold months are the near Passivhaus refurbishments xxx road that we have done and T Bere's office and in Darmstadt this year in Spring time the buildings we saw there which have that sort of similar quality to them – as well as temperature, particularly in cold months when the windows are closed it is the freshness that you encounter in every room that you go into – I went into a house yesterday, a Victorian house and went into a room that had obviously not been gone into for maybe a few days and it just had that sort of fusty stale smell and that is completely gone from these buildings which is remarkable and

Me – and you put next to it that MVHR improves indoor air quality and PHPP is developed well for UK design scenarios – I think the MVHR comes off the first point really doesn't it - and the MVHR I was suspicious about too psychologically there are lots of questions – will it be noisy will it be draughty will it actually give you enough air will the room start to stink after a while – certainly the houses I have been into that use it do feel much fresher, much more comfortable and so I am completely sold and the more I find out about it the more I find it is not so sophisticated and it is much less sophisticated than a gas boiler – in terms of PHPP being well developed for UK design scenarios I think that is just by default really because the climate in comparison to Germany is not so different so that seems to work pretty well anyway – from what the Passivhaus Institut say, even Passivhaus in Greece is – which wouldn't have seemed an obvious choice for it to work – they claim it does – I would be interested to visit those places really because I was quite sceptical and didn't quite believe it

Me – there are some in Spain too...and Italy. There are definitely articles in the previous Passivhaus papers that you get for the conferences – I was going to ask you about that end – we understand building fabric performance well in the UK you have given that a really you don't agree with that

F – It is a personal thing but before I entered the world of Passivhaus and people who do understand building performance and building physics – I thought I had a pretty good grasp of things because I had been to a technical university and we had been taught about U values and ventilation by respected engineers and therefore I thought I was pretty safe actually but during three years doing my own sort of study on the subject, I have come to realise that I didn't know very much and probably had lots of things quite back to front

Me – so how would you rate the teaching on that side of things in your training?

F – comparative to other schools it was probably very good – but compared to what I know now and what I think all designers and all people in the built environment should know – it is pretty awful and sadly I think that continues at most schools of building design and architecture now with only one or two exceptions – including where I teach myself

Me – Where do you teach?

F – I teach at Greenwich

Me – do they spend a lot of time teaching this kind of thing there?

F – very little – the course I am in charge of is called construction so all these things fall within that but there is not enough time-tabling time to actually deal with it very effectively - I think we have improved things significantly in the last couple of years but I need really three times the amount of time

Me – One thing that often comes up is lack of communication between – I don't know if you have got it as one of your points – yes you have got UK design skills are appropriate to design Passivhaus buildings as a minus four – actually I will go back to what I was going to say before – co-operation between different design teams like being able to understand what they are saying to each other like engineers and knowledge of building fabric

F – sadly I think a lot of engineers – their knowledge of building fabric issues particularly thermal bridging issues and breathability and interstitial condensation are very week as well – most engineers are quite good on big picture stuff sort of strategic stuff but at a level of detail – the knowledge is quite weak and I think that that is exacerbated by – ultimately they never get paid to go into that level of detail and ultimately they never get paid to go into the level of detail that they do anyway so that perpetuates the situation where nobody has really got to use PHPP – very few – I know more architects using PHPP than engineers – and thermal software and so on

Me – back to UK design skills are appropriate to build Passivhaus buildings it seems that you were quite lucky with your design team – in the project that you have just shown

F – I was lucky with the client too – they had an aspiration to do something way in excess of any building regulation but even building regulation for new build doesn't drive the regulation hard so if it is not being drive, nobody in the industry is going to equip themselves with the knowledge – it is only when people are kind of into it that they are going to spend time learning about this stuff cos – it is quite intensive

Me – do you think it is do-able?

F – I think it is because – it is fair to say we sort of drifted into this world by accident really and at first I thought it wasn't really achievable or attainable – and when we did the Culford Road project I really had no idea whether we would achieve an air-tightness of five or an air-tightness of 0.5 – but we discovered actually that if you followed what the book says not what everybody tells you that you will probably do reasonably well and when you have got a reasonable amount of experience you should be able to do very well repeatedly so that was the same for everybody involved on the site – the builder had never heard of this concept and so they probably thought we were all a bit mad and a bit obsessed about something strange but when the tests were done and it became visually evident, then they got quite excited about finishing the tape job and – so from a standing start from within months we got from normal UK standard to better than best practice on a refurb – so surely new build can't be that hard is my conclusion

Me – and stuff that you have put in the middle – would you like to say anything about that as to why it has ended up in the middle

F – things to do with planning I don't think the planning system either supports Passivhaus or rejects it necessarily – I think building regulation should support it more, we ran into some issues with planning on things like windows particularly on the retrofit end of things – people aren't actively against you and again I think a little bit of education would go a long way so I don't think there is anything per se that is wrong with the system it needs a bit of tweaking

Me – you have put that the Passivhaus standard is very flexible in this zone too

F – overall I think it is when you look at all sorts of different types of buildings and I speak for someone as an architect – when you look at all the Passivhaus buildings that there are they do look remarkably different on the whole – and I can imagine a lot of architects – I think that most architects are scared of green building because they think that they would have to adopt a green roof and a certain sort of cladding and that it wouldn't look cool – I suppose the architectural equivalent of a sandal is how they thought we would end up but I think that – but I think that that is just kind of a myth really and if you understand the system well you can be architecturally reasonably flexible enough

Me – you have also put here that Passivhaus can be difficult to construct in the neutral zone

F – again I don't think that they are per se if you understand what you are doing and if you are strategic about how you put things together and care about sequence and careful about that the first work is done very well they are really no more difficult than a common builder sort of bodging it as he goes cos usually builders create quite a lot of problems for themselves in the way that they work so and certainly experience suggests that a decent sized housing scheme with a bit of off-site construction can go quite quickly and reasonably cost effectively

Me – yeah cos you have also put that Passivhaus designs are too expensive in the neutral zone

F – again I think they are not per se – certainly new build – but going to Passivhaus on existing buildings obviously I think that that is a judgement really on what is expensive and it is tens of thousands of pounds to get anywhere that is near approaching Passivhaus but a lot of that work is work you would otherwise do in the course of time to stop the building sort of crumbling around your ears and in the long term if you build a building that is constructed to Passivhaus standard it is going to be much more robust and around a lot longer so I wouldn't class that necessarily as being so expensive

Me – what would you say about the spread of statements overall – do they cover issues that you think that might affect the uptake of Passivhaus design in the UK? Is there anything that you think is massively underrepresented?

F – I think actually if I had been asked to write down a list of statements there is probably more here than I would have come up with myself - I think that those are the issues

Me – and is there anything else you would like to say about the things that you have put down?

F – I think my experience of getting my head round the concept has probably been like most other people's to start off with – assuming that inherently it is going to be phenomenally expensive – you wonder whether it really works and you wonder how robust it is – you wonder about the quality of environment you are going to get and you wonder about whether you are going to be put in this sort of design straight jacket and all those sorts of issues and pretty much over time as you address those issues you are convinced to the opposite and anybody I know who has spent time looking at it has pretty much reached the same conclusion and we have had debates in our own office too and certain people who a couple of years ago were really anti MVHR – it is just kind of an anathema – it is not natural – are slowly kind of changing their minds and that is not just kind of bashing them over the head with figures it is kind of experience of being in buildings

3.K – Architect and Passivhaus Designer

Me – have you worked on any Passivhaus projects in the past

K – We worked on a bid so we designed a Passivhaus scheme – but the bid it wasn't successful

Me – where did you first hear about Passivhaus

K – I think it was through the AECB

Me – where did you study architecture

K – Bath and Plymouth

Me – what would you say were the main issues affecting the uptake of Passivhaus design in the UK Mark – a lack of understanding is a big one – and a perceived cost barrier when compared against what we currently have to build – I think that barrier will fall away as we have to build to codes 4 and 5

I presume cost means capital cost rather than whole life cost

Me – yes that is a really brilliant thing that needs to be brought up in terms of how we perceive costs – actually while you are here do you have any QS's you have used to cost Passivhaus, I am having difficulty finding a suitable QS

K– no we didn't cost it – that was for a Cornwall scheme when we were designing to Code Level 4 and 5 – one of the problems there is that it was an unfunded bid and you have to do the two designs – so we designed it and worked it through in PHPP so to verify it for code you have to have completely reworked it through SAP and through the code tables so when you are justifying and you can't assume that for PHPP it is at all equivalent – so I was wondering if that is one of the reasons that the bid failed because it was not understood – it was in my home town, I grew up there and there are lots of reasons why we must have been good candidates but we still didn't get through

Me – well it is still on the kind of out there scale in terms of people knowing about it and it is scary new

K – I guess that most QS s would have to rely on going directly to a supplier for getting MVHR installed and windows and all those elements – the rest of it you could probably cost out as really straight forward

K – I am going for the legislation ones as the biggest barrier I think...

For us – most of the Passivhauses that have been built have been built by small companies and small practices doing one off houses and that is generally how it has been done – John Williamson

has done the first two which are small and we are probably a little bit unusual as an AECB member because we are bigger than most of them because most of their members are 2,3, 4 man band architecture practices or small companies and in terms of the architects well we are different cos we are kind of 25/30 people and we are a lot bigger than some of them – I am sure there are bigger members than us but we are probably a little bit more active and for us to commit to – when we supported Passivhaus buildings it was really a no brainer for us to commit to it because we have kind of convinced our board – I mean our board are non-architects – they are involved in the construction industry but they are not architects – they have seen and been convinced by us that Passivhaus offers a kind of unique selling aspect for ECD as everyone starts to design zero carbon buildings we still want to be doing things at a leading edge and Passivhaus gives us that and our board recognise that and we have a lot of queries from current clients and contractors – do you know what Passivhaus is – so there is a recognition by the non-architects here that it is an important area that we could be getting into so they have supported us and actually stopped our UKGBC membership because it was quite expensive for not much benefit and have argued that we should put that money instead into becoming a member of Passivhaus Buildings for two reasons – one because it would give us a much stronger knowledge base cos we haven't built any and I am doing the certifiers designers course in September so we do have some knowledge, but it was the back-up of being part of that organisation that was important – but the other aspect was if we are going to pay out all that money two grand a year then we want clients to come out of it and the opportunity to be round the table with contractors or developers who are interested in Passivhaus it was a good investment – that was how it was seen – so those are the kind of twin tracks – knowledge and clients that justified us joining that but what I kind of – it is unclear to me what is happening right now, but it does seem that the expertise and the knowledge that lies with the core AECB members and their links to Germany is in the Passivhaus Trust but that kind of thrust commercial, let's get this happening that SS offers is out in another organisation, both of which now want expensive fees for us to join and all of a sudden we are having to make choices about which is the right one – and it would be difficult for me to go round to my board and say well you know all that Passivhaus stuff I was talking about that we were going to join – well we are not we are going to join something else called the green trust or something like that and there is no hint of Passivhaus and there is no kind of links to Germany and all the things that I argued the first time round have all kind of split and it is in a really difficult situation I think. But I don't know I had a long chat with Jon Bootland about it and I am waiting to hear for the Green Gauge Trust and I am waiting to hear what the Passivhaus Trust have got to say about it – before we decide how we invest our money – the complication now is that when it was all one thing – we were approached by them trying to put together a retro-fit course and which we kind of agreed to do and I just don't think we will have the money to join two organisations – it's not a great outcome for us –

Me – I think that comes out in one of the statements about the clear leadership thing – even before this situation it was something that was in question because

K – isn't it going back to that point about AECB membership – a lot of smaller practices they have got no desire to be sitting around a table with bigger mainstream contractors because that's not where their clients are – it's nothing to do with them – but we can't do one off houses it just doesn't stack up cost effectively for a larger practice and we might kind of do one as a loss leader just to get it on our books but we need to be talking to the bigger developers to get larger schemes and we are talking to RSLs about – but we keep coming second in competitions where we have pitched to Passivhaus and teamed up with people – and it is just kind of making that leap to a Passivhaus commission that we find that we are struggling with at the moment – and I was hoping that the Passivhaus buildings as it was would have kind of broken that barrier because you would have been sitting round the table with lots of different people and you would be looking for opportunities together to build to Passivhaus standard – well I am still waiting to see how it all pans out really

Me – I really don't know what went wrong with the politics?

K – I think it was core AECB members feeling uncomfortable about sitting round the table with the big boys – it was too commercial – the AECB is at its core about being a grass roots, free, knowledge sharing organisation and it is not part of their psyche to be commercially driven

Me – they are just community knowledge share driven –?

K – And that is where the split has come but for a practice like ours that is a really unhelpful split cos we want both

Me – yes cos you need the pioneer guys to talk to and you need the big guys to talk to

K – yeah exactly we want big commissions but we want the expertise as well so I don't know where we are at the moment I am going to have to see what the costs might be to be involved in either or and especially now cos we have just lost some schools projects due to cuts – so how are what are we going to do now and things like this are really difficult to justify at the moment it is a real shame – I spoke to D Parks yesterday and he said there is a launch on 14th July and it would be nice to know before then – how can you launch it with your founder members in July when

Me – is that for the Trust or the new one?

K – When two or what are we three weeks before, potential founder members haven't even been told what it is all about – seems a bit premature to me but I guess they have made a booking and have booked somewhere

4.L – Architect and Passivhaus Designer

Me – are you happy about that?

L – No because I would like more to the left – I disagree with more than I agree with

Me – Why do you disagree with so much?

L – well Passivhaus buildings have to perform as specified to work well you could say that that is not necessarily true cos if it was a well-built house that was designed for Passivhaus it doesn't have to perform as specified to work because Passivhaus is such a strong standard – Passivhaus is equivalent to the Code for Sustainable Homes 5 and 6 and it is my own feeling that we will never get to code 6 cos they will get to 2015 and say oh look Europe's got this really clever Passivhaus system why don't we opt for that instead cos then everybody's singing from the same hymn sheet and they should have just said lets aspire to Passivhaus by 2015 like Europe has but let's start building some now – the UK is full of stubborn people that don't like to admit that somebody is doing it better than them – when Ruth Kelly did her thing – the code for sustainable homes her statement was 'we are ahead of Europe' in doing this – Passivhaus came along long before Ruth Kelly even thought about the Code for Sustainable Homes

Me – and at this end you have put that the UK construction industry has a fast-buck mentality – Why?

L – It is just the nature of the industry that we are in – they like to get as much out of it for as little effort as opposed to if you visit an Austrian factory, the factory has multiple levels of bonus so that if a man on the factory floor comes up with a new idea that improves the profitability of the company everybody in his team including him gets a bonus as a result of that and it is shared – which is slightly socialist in its approach – which is how Scandinavian factories work – but in the UK they don't everybody is out to blame the other person for doing something wrong

Well I think the UK building industry as Europe is closer for us certainly we have for our supermarket we have Scandinavian window manufacturers in 1989 I did a house using a Norwegian window that was factory finished with aluminium drip trims – double glazed and factory glazed and delivered to site for less than I could buy a xxx window without glass and that was in 1989 so now we go to a number of different manufacturers around the world and we get Czechoslovakia for the same project would be about £9000 but can't do what we want them to do because they don't have the factories to do it , Austria sits in at about £19,000 and UK joinery company building to the same specification £32,000 – where are we going to buy our windows from? There isn't a UK window manufacturer – we are trying desperately to get them to build to the same sorts of standard but the UK is not prepared to put the money into research and development that Scandinavians and Austrians do

Me – where does their money come from does it come from state or is it private individuals understanding the validity of investment – who is putting the money in?

L – I don't know – when I visit a factory which has three men building houses with trees going in one end and robots building houses and houses coming out the other end – and the man that drives the truck builds the house or erects the house on site and that has been happening for years – and one of the things cos I've worked out in Europe, I've worked out in Belgium, Norway and Sweden as well as in America, the European house building market is very different from the UK house building market in that the Government be they socialist or not will create an infrastructure and build the roads and create the plots and sets a design brief that says 120 square metre max and no more than two storeys and chalet bungalows or whatever you want to call them and the client will sign up to a plot and go and find their house manufacturer – the UK differs from that for obvious reasons – the developer will buy a piece of land – he will have so many house type and he will pull out of the bottom draw, six type a and 7 type b, six type c, they all fit really nicely in the scheme and they don't relate to the sun whatsoever and they are just plonked onto a site because they sell well and the developers are telling the public what is good and the public don't understand what is good – they do understand when something is bad but not until they get in the house and they see the bills

Me – but what does it take to make the Austrian system work? It actually needs some very highly skilled and trained people to set out those parameters with which they work in the first place

L - There is an element of that – but if one could persuade a UK house builder to take a piece of land, obtain outline planning permission and do a design brief, they could put in the infrastructure and the roads and put all the services on and set again the design brief that meets the criteria – cos when you look at the dross that goes up – my parents bought a house in Cambridge of Ely rather and it was an Abbey home and exactly the same house I saw going up near Whitstable in Kent and we have had a really interesting conversation with a developer recently who has 400 different house types that he rolls out around the UK but now of course he has got to try and get to code level 3 so they thought that the instant way of doing that was to plug-in ground source heat pumps – then they were quoted £1.5 million by EDF energy – because of the start-up currents – no they were air-source heat pumps – was going to be so massive and I have ruled that out – and I am asking you how much is it costing to add the various Eco bling as I would like to call it to your standard house type and he said it is costing us £12,000 a unit to get it to code level 3 and I said – if you give me £12,000 for each house type that you have – I will re-design that house-type because that is what you should be doing – because they have only just changed their cavity wall insulation from 50mm to 75mm – now to get to Passivhaus I think the Denby Passivhaus has got 300mm of insulation in a cavity wall if you are going to do a cavity wall construction – my own feeling is that provided you can overcome the lack of thermal mass in a timber frame building –

then timber frame is the route that should be followed because that is the route that has been followed successfully in Scandinavia because of the raw materials that are available

Me – so what is wrong with us – why can't we get our heads around these things? Why are we not performing? What is stopping us?

L – because when it comes to things like Hoffhaus they are very Germanic in their design – well I was in Scandinavia in 85-87 working for a UK developer with a Swedish director – if you are borrowing money in the UK – if you can build a house in days rather than weeks and have that house on the market much quicker than you could afford to build a factory in the UK to build them – all you had to do was to manufacture 50 houses offsite to make it tick – 50 houses a year which is nothing and they were a 400 house a year developer plus – so I went to Belgium and worked with a team in the factory and worked on site and I was tasked with transposing UK house types into the Belgian system – the Belgian Government came over there was going to be Belgian money involved in it and UK money involved in it was going to be 88 when it happened in 89 we had a huge property crash, so it just didn't happen the only thing that did happen was that the Belgians quite liked the English house types there are some of these Wealden house types that have been built in Belgium by the factory over there but the factory was never built here – I think as I have said before when the whole idea of the concept of timber framing came into play it was badly done and therefore there was a resistance to it not only from the people living in the houses but from the insurance companies due to some failures – so we live in a masonry world – I think our climate lends itself to having some thermal mass but of course there are other ways of achieving thermal mass in a building

Me – with aerated clay bricks

L – the thing about those are it's the fact that you have got to re-educate the brick layers because they can't just lay them the way that they lay normal bricks they have got to use the grid to lay the grid along to it is like the whole idea of thin bed concrete mortar, they can't get their head around it even on the simplest of building to try and get them to do a fully pointed block-work joint which has got to be stronger as well is difficult enough – you have got to start educating the tradesmen on site to do things in a slightly different way than it is about doing it in a better way but then the UK construction industry has got this fast-buck attitude – so much of it is done on piece work – the main contractor might be on a price but bricklayers are on piece work at the end of the day they are going around counting how many blocks they have laid because it is how many pints of beer they can afford and they are not looking at how well they have done it – and the site supervision in the UK, one of the first things that gets knocked from a scope of work from a client building a house is – I'll be my own project manager, I can save myself that money – I see that happening all the time – and in one case where we thought we could achieve code 5 with a really gorgeous timber frame, fully insulated, externally insulated, OSB lined, service void, membrane taped,

MVHR, they are going to know the MVHR on the head, sorry we are project managing this, lets save a few bob on the MVHR, Austrian windows, beautiful windows, no trickle vents – they had to put two bathrooms, a kitchen and a utility room all had to have mechanical ventilation, because they didn't have trickle vents because the windows were already on the way, they had to put vents through the walls in certain rooms – hit and miss vents, so the whole building just fell apart when it came to air-testing – it's just ridiculous – but the cost of all those things that they hadn't prepared must have been only hundreds of pounds cheaper than the MVHR system initially and of course they are losing all that in heating the building – I think that to build air-tight buildings to the level that we now need to build them to – and I say now because it is now – it is going to be about serious site supervision – and having little – what are they called – toolbox talks with the guys on site – we have found in the last twelve years that talking to the contractors that we are working with to get them to understand how we want it what we want, and they know that if we don't do it the way we want it then we will make them do it again – it's about junctions between, walls, floors, roofs and windows in walls and all those sorts of things – so you are re-writing the rule books so that you are re-writing the way certain blokes have done it over and over again – a young tradesman who is a tradesman as such because of course the days of apprenticeships are long gone – it is all done through college so it is a little bit tricky but then the tradesmen that we are coming across who are doing the day releases at college – which is grant assisted are the ones that are prepared to learn and listen and do it properly but with a recent MVHR system that we were putting in we were training a plumber to do the work and the engineer that designed it was working alongside us so that I can get a really good understanding and I am doing the ductwork with the plumber to make sure that it is going in and where it is going it in – so we have got MVHR ductwork that is being incorporated into cavity walls that are there just from a sound insulation point of view – so the bricklayer says all right L, we'll put them in for you, but you know it is not going to be done properly so you pre-make it off-site and take it to the site install it they plug it in – and I think off-site construction is something that is going to – I think there is going to be an exponential curve in off-site construction to volume build houses in a controlled environment but then again I have been to off-site construction factories in the UK where – unfortunately for the company they had a window in the meeting room looking down into the factory where the guys were making panels for a school – that were supposed to be fully insulated and we were watching the guys manually putting the insulation into the panels, not particularly well, and then of course you have got a membrane going over the top and nobody can see whether there is insulation in it or not and that is the UK construction industry I am being paid to make a panel, panel for panel, if I put the insulation in quicker I can get more money at the end of the day and it will only be revealed when they thermally photograph that building and find out why it is not working – so I think we all need to have close circuit television monitoring building sites 24/7 to keep an eye on the guys

Me – this is all very well but you say this is in a factory – where they theoretically had a window where they were observing their working but nobody was telling them that they were doing rubbish – which seems to be a key issue

L – yes most definitely, it is about quality and maintaining the quality of work but then you expect someone like Toyota – where things are built in very controlled environments not to have to recall thousands and thousands and thousands of cars because there is a problem with them –

Me – yeah they wouldn't survive

L – no – the building industry is one of those industries where if the guys can get it away with it they will and if you don't supervise it properly or if you are not wise to some of the short-cuts that they are trying to take, then they will get away with it – now that we are having to air-test buildings the importance of the air-tightness side of things with the guys on site when they are doing the job – you have got to get the insulation right – you have got to get the fabric right but the real thing is going to be about junctions – pro-klima is somebody definitely to buy shares in because their products are brilliant – we are using them a lot but with any air-tightness product it is going to be about its life-span – you are going to get the guys on site who are seriously good mastic specifiers and who will get the cheapest approved mastic because even though somebody has specified it – who is going to pick up on the fact that it is a cheaper mastic therefore they will gun it in and it has cracked and it is not doing what it needs to do and we live in a land where we don't do it right – it is generally that the UK doesn't care because the guy at the end of it is not going to be paying for the house – and likewise, when you see house builders building rubbish houses with walls that are paper thin and they are now going to have to account for the energy use – well how long did the Housing Information Pack last because there were loads of people out there who thought instantly I will go and do my HIP training and then a developer would say come on mate I need a HIP for this house or an estate agent would say I need a HIP for this house – no-one really cares, no-one really understands them there must be loads of back-handed HIPs going out there and there are buildings that have got energy ratings and you know damn well they are not achieving them

5.M – Architect and Passivhaus Designer

Me – so have you finished the Fulham project?

M – it got finished – the client went peculiar – very peculiar so not long after we went round relationships between the client and the contractor kind of fell off the planet and I don't know what happened unfortunately – it was a real shame and I did try to get him to still let me go and have a look at it – the guys who are actually on site who are Hungarian said that they thought he was very odd

M – This one here – there are financial incentives to build Passivhaus designs in the UK by that do you mean there are grants? Or do you think there are very good financial reasons

Me – I think that it is up to you to interpret that but some people have used in terms of grants specifically but other people have seen in terms of you can actually get good energy pay back over time

M – that is how I would see it in terms of – I mean that is how I would interpret it

Me – are you happy with that

M – Yes I think so without spending hours and hours – I think generally

Me – would you have any specific comments about any of that?

M – I think the questions clearly come from people who have had some experience with – so that is quite apparent that they are sort of informed questions as opposed to questions from the general public and I think the questions themselves reflect the issues that are apparent if you see what I mean and clearly those issues are to do with the construction industry and the perception of what it is and what it achieves – I mean I have put hear that people in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs and I think that that is the biggest thing – it is a complete misconception this notion of living in a sealed box – it is the big thing that people say – why can't I open the windows? – And I think that that is a complete blocker for clients and architects and the general public

Me – so how do you go about explaining that to people? I suppose without being able to take them to any examples

M – This is what I think is needed – people need to see these buildings and walk in them – we explain it simply by saying in the winter you don't generally open the windows – and it does take a while for the penny to drop – I think that the key word that is the problem with that is air-tightness and they see it as being hermetically sealed – they hear it as being hermetically sealed if you see what I mean

One of the big advantages in London in particular is the filtration of air so you don't get your house filled with dust and exhaust fumes – it is quite difficult to explain to people

Me – what about the other end of the scale?

M – I think one of the things is that a lot of people think that they are restrictive and this is related – they feel that the air-tightness will restrict how they use the house – that is not just our view that is from talking to people they feel that then there is some restriction on opening the windows which of course there isn't but it is just the way that it is put across – I think it clearly is in the presentation of the mechanical ventilation with heat recovery issue and the air-tightness together have confused people – but I think that the whole notion of understanding what the MVHR does in terms of energy and sound quality is not brilliantly understood – clearly this is something in conjunction with a number of other things – if you put it in (MVHR) to a number of buildings where it doesn't meet the required air-tightness then yes it will (use more energy) as it is just like sucking air in and blowing air out – it is just the wrong piece of kit and I think this is probably something that is not well understood in the British construction industry – is the interconnectedness of the design process the execution and the kit is not an add – I think we are too used to in this country bolt-ons – that is not part of it and I think that which is the whole approach to low energy design is that it is not about add-ons and too many people in the construction process think oh we will just add a solar panel or we will just add a this so I can see why that statement is there

Me – how do you think that could change in terms of awareness raising – is it through the education process?

M – I think it is an educational developmental process and more people do it already and it is the ripples in the pond and the information goes out – of course it is restricted by the slow process of the building basically

Me – yeah two years done the line kind of thing

M – exactly with the best will in the world – designing a new build house it is kind of six months to a year to get planning permission, 18 months to get on site and – it is a long process – it is not kind of next week – but I think having said that it is a slow build up and it is kind of exponential potentially

Me – kind of two leads to ten and

M – exactly but I do think that not having any particularly large number of built examples for design professionals and the construction industry to visit is inhibiting the whole process – yes you can go to Germany but it is a long way

Me – it is a long way and people don't necessarily see it as like

M – no and I think that is because English houses are very different – I mean cos in Germany everybody has a basement – and their space standards are larger and their requirements for storage and recycling – the whole process is – well they have got more space so there are a lot of things – but actually I do think that – there are so many things that could get brought in that are beneficial, I mean that the GLA have done their thing on space standards which is going back to Parker Morris of course which is where we all were ages ago

Me – yes exactly

M – and recognition that you need

Me – a space to live in?

M – well you do and I think that the spaces that have been paired down are not good – hence the burgeoning market in storage because nobody has got anywhere to keep their sports kit which is ridiculous – you do need a certain amount of plant room now if you want to adopt a low energy house in terms of just

Me – no it is not just the boiler space is it?

M – people have done away with hot water cylinders because they have these combination boilers but now if you have a solar panel you have got to have a cylinder and to make the most of MVHR you should have a cylinder as well – so it all adds up and then if you have got PV panels, inverters and the meter and all the rest of it so it does mount up – there isn't space but I think all these things and the monitoring things should be very visible anyway

Me – absolutely and also for maintenance

M – well I think having meters visible is crucial to having people understand how much electricity they are using – rather than being kind of tucked away – but just being on the level of being able to have storage for recycling – there should be a dedicated area in the house for recycling so that people can do it – I think there is still a lot of ignorance about the benefit of insulation and two fold that is – not just the environmental bit and how warm it keeps you but in the amount of space it takes up and that needs to have an allowance made for and again that is something that has to get through to space standards and or planning authorities for example this new house that we are hoping to get built up in the Chilterns is in an area of outstanding natural beauty – you are restricted to an area of 120 square meters

Me – total

M – Floor area, on a new build house which is nothing which includes the external wall – you know your external wall is 400mm thick if you want to make a zero heating house – then you are penalised for that it is ridiculous

Me – why do they have that specific standard?

M – I have absolutely no idea – well I think it is to stop mega overdevelopment – 120 square meters for a three bedroom house

Me – it is like a cottage?

M – well if you are wanting to build your own house, one of the reasons people do it is to get more for their money – and it is not generous but that is what it is and those things need to be challenged and revised so I think there is a lot of things – people's approach and to be re-assessed about and I think also it just goes into the sort of into the realms of – I know your focus is on Passivhaus but the whole focus on reducing carbon emissions has to come back to insulation – reducing your requirements it is the only way you can do it

Me – what about how you think people perceive insulation and keeping buildings cool with it?

M - Well funny you should say that, we have got this project which is a factory in Brentford that is a kind of green business and the client wants to move in and make it into an office as opposed to a factory and it is single skin blockwork – big kind of 1930s factory – big windows facing south no insulation anywhere and we are just looking at it in terms of meeting indoor air quality – how are we going to do that ventilate – mechanical ventilation blah blah blah but the whole thing about heating in that space is that they are going to be 30 odd people with computers and the biggest problem there is going to be overheating so the challenge is I have got to start and do a model in TAS – is it any point insulating it? I don't know the answer yet - is that a good use of your money – because in the summer you want the thermal mass to help your cooling and in the winter you want – if your internal gains are so high – do you need it anyway?

Me – well it is just balancing these things out

M – but it then comes down to making a cost assessment to the client – well you can spend this much on heating or you can have insulation but then you can have cooling yes – I don't know the answer

6.N – Architect and Passivhaus Designer

Me – so they are wondering what they need to work to

N – yes they will be wondering what code level they have to hit and that is what they will work to - you can passionately ask them to build to code 6 but no change – they are thinking about the bottom line all the time – it is like that thinking about the Passivhaus until it is going to be regulatory then you are not going to do it – you might find a particular type of developer who would do it to make some kind of get the ball rolling, but there is nothing in it for them because they need to sell the houses at a competitive price to the rest of the market at risk

Me - yes there is definitely potentially more risk at the moment

N – Another thing – I need to chat to the guy who is doing the PVT cells he was saying that when we were starting the OKO house that for a full kind of energy system it would be about £20,000 to get your PVTs on the roof – now he is saying it is about £40,000

Me – that doesn't make any sense at all – I think 20 sounds a lot

N – if you know anybody cheaper let me know – you know PVTs are the combined PV and solar thermal – that was 25 square meters of that, borehole, storage and fitted

Me – that is crazy it must be the cost of the house?

N – I haven't spoken to him about it I will have to speak to him but part of me doesn't want to speak to him because it seems as if he is trying to get as much money as possible for the system – he is a business man he obviously feels he can get that amount of money for the system –

Me – that is a hell of a leap

N – so for number 11 I would put cost and regulations – 12 we are not really looking at Passivhaus except for our OKO house project – a few kind of developers have asked us to kind of look at it – one from Luxembourg and the one good thing about that is that he put us in touch with Rico – I don't know if you have come across Rico – based in Slovenia – they do really nice wood stuff – so that is one good thing and I think that Rico will do a very economic Passivhaus for you – whether what you want is solid wood or a kind of stud wall construction type technique

SB – they were saying that if they can afford to save £4000 a year on energy bills then they can afford to buy the house up front because they don't need to worry if their pension falls down – and also they are cool – the baby boom generation from the sixties have a certain foresight and ethical grounding – we were in Atlanta in Georgia and there wasn't really that openness but it was very clear that just in terms of costs and just in terms of ethical values – there is a hippy hangover – there was that baby boom generation that would be interested in Passivhauses – for two really

really good reasons one for that it is smaller than other houses and they don't need such a big house because the kids have gone – the other thing is that they would know exactly what the house would cost from day one when they build it and in terms of operating it and the other is it is just the right thing to do and they are a generation of people that do the right thing

Me – I guess it is also lifestyle – the freedom thing

N – and I can imagine it being exactly the same in the UK and Europe – that actually it is a much better market for people to take those risks – in a way I think they are more comfortable because it is quite an analogue thing and so it is the reverse of techy although there is a lot of technology involved in it designing it is affordable

Me – which means you can go off around the world and afford your holidays etc.

N – It is just raw from real – it is not complicated the house is built and it is insulated and all that – there was also younger wealthier people who were interested in experimenting – who had – trustafarian type people and they were interested just because it was a cool thing to do and nobody – and there were lots of people who were interested for that reason as well but there is no middle interest at all – there is such a – it is all the Ford fiesta types they are just not in the least bit interested

Me – but you are going to get like social housing here and you are going to get the upper end and in the middle you are going to get

SB – not interested it is more important that the houses are bigger and that it has double garages

N – Especially in America – there were a lot of places that were built so cheaply – a million pound house just built from OSB board with no insulation in between –

SB – we were slightly put off at the moment by doing a big effort there – the Green Building Council wheeled us around as if we were like a royal visit – they couldn't believe that people who designed houses at this level were interested in Georgia and we were given fantastic opportunities of meeting various people because it is so far behind – 25 years behind Europe

Me – the thing is I always feel like the UK is 20 years behind the rest of Europe and then if the States is 25 years behind that – help

N – exactly – honestly it really is the case – the house that we were taken to that was supposed to be an eco-house was just horrendous absolutely horrendous – there were no eco credentials that you would recognise that were something that people would list – two stage toilet flush and insulation in the loft

Me – actually I have been to a few places like that here and have been shown round by developers and they go here – and you are going like what

N – Yes and they will say yes we are using resin for our worktops and MDF skirting boards

Me – and you ask what do they normally use.

7.O - Architect and Passivhaus Designer

Well I first worked as a bricklayer and I was trained, I was trained at Hackney College and I wanted to find something about the history of brickwork and I went to the library and the contrast between the library at Hackney Technical College of Building or whatever it was called then and Newcastle University the Architecture school, was so devastatingly obvious – it just said it all about who actually is worth giving books to, who can actually find out about – who is allowed to have knowledge – it was so striking – and obviously that has really changed – the internet really, really changed that a lot but I still think it underlies our attitudes to education in a quite fundamental way and we are sort of really – we are very – educated people are sometimes quite patronising about what they think other people might want to know and I used to often say – I used to often ask people, are we are doing this mix right, what's in this, what exactly is this mortar, and all the people I was working with would want to know but they were not going to find out, so they would go – go on O, go and ask, go and find out we think it might have a bit of this and a bit of that in it – and then there was all this thing about you couldn't go and you mustn't have people talking to each other because that's when you get trouble on site – so that actually stopped people finding out things as well – so you can't have, let me tell you about this particular project like I would do now if I was on site – I would start by saying we are building this hospital and it's going to be like this and this is why we designed it like this and these are the things that are really important about how you are going to build it – and they really hated those kind of things and they didn't do it because people would have to talk to each other and you would get one bit of the site talking to another bit of the site and that is how you get insurrection.

I am sure all sites are different and loads of those things have changed and there is a sort of professionalization that has happened but at the same time there is also more people who are employed in temporary jobs, there is more piece work there is more sub-contracting so in some ways it has got worse.

The way the industry trains is linked to the class basis of society and that is still there even though some of that has changed, the way that the industry is structured is still the same so you could see if I worked on site as a bricklayer, you could see that when people were walking around – you could see that those lot over there are architects, you could just tell...

Me – so the architects would be at the higher end or the lower end of the class spectrum?

O – Architects come from middle class educated backgrounds on the whole and people who work in construction come from working class backgrounds and that's changed a bit but not nearly enough and not nearly enough and there's loads more about all of that ...

Passivhaus is the tool – PHPP

Me – do you think you will be using that on all your projects from now on?

O – yes I think we will – yes I think like that little environment centre it's a single storey building it's got a cafe in it, it's a tiny building so quite difficult to achieve and in a way it doesn't matter that much in the end whether you do completely achieve it or whether – what that matters is that you have done your best to use it as a tool, you have got the best advice – you have made the best overall decisions balancing it and you have got the best that you can do – so the difference in the design using that as a tool compared to not having it – I've been going on at the services engineers for the last fifteen years saying what happens if I do this? I think we should do that, what happens if we do this, how does that relate to...

Me – so you are not actually doing it yourselves, even though you are working with a services engineer anyway whatever happens?

O – yes but here we can do it ourselves, it is easy enough to do it ourselves, enough as a design tool, obviously ultimately we are working with the services engineers and they are doing their stuff as well or they are using Passivhaus as well, so like on the environment centre, we worked with Alan, so P did it and she sent it to Alan and he said oh look at this and look at that so you know that that is good anyway – you know that ... In the past they would just say that either they could model it and that it cost too much or like you were doing it in TAS or something or IES - it's really expensive, or they'd say that some things like some of the thermal bridging stuff was really difficult to model – I mean ten years ago it was really ...

Me – are you doing the thermal bridge modelling here too?

O – yeah – yes we are doing that as well – so that's really good and it is also to do with P just getting up and doing it and being into it and it's feasible within a small practice whereas TAS isn't or IES, we just couldn't afford to do that

Me – I remember about using IES in larger practices where I worked in the engineering department and they were struggling getting enough people who could use it and getting their head round it and making sure that the right data was being plugged in and it was all a bit of a headache for the trainee and very expensive

O – I feel much more confident now that – in the past we were sort of doing things on trust on sort of good sense, which you might get wrong, which you do get wrong sometimes, like I remember on one project I was really anxious about solar shading and it was a nursery and we went backwards and forwards getting the solar shading company to model it and they kept saying it was alright and but it wasn't really – it was alright in some places and not in others – you needed to sort of hold – if we had had PHPP it would have been much clearer what was going on I think

Me – clearly people use things like IES and TAS later on when you get a really complex bit of... but once they have sort of sorted it out in PHPP to start with?

O – so it is sort of at the right level and I think it is really not at all surprising that it developed in Germany rather than here because it is sort of ... because architects work at that level in Germany, you are expected to understand how a building works and you are expected to do daylight calculations and simple structural calculations – there is an expectation that architects are more technically competent than here and they do more management stuff on site and they do more – they are more like trad architects here doing a bit of everything

Me – they have actually two different types the ones who do the office work and the ones who tend to do all the site work?

O – But in small offices they do both and

Me – so you think we have got a real big issue in terms of the way that we train our architects here in the UK?

O – yes – I think it has got better but yeah – I think we as architects have given up a huge area of design and we have got the wrong idea – architects just sort of do the surface of a building and I don't think that that is what a building is about – I think that it is a whole three dimensional inter-play of light and space and environment and that is what architects should be designing for ... so I think building physics should be something you should do every year in architecture school and it should be a design subject it's not just...

Me – somebody suggested that perhaps all the trades should train together – just like in a foundation year?

O – Yes that is what I would like to see

Me – and then some people are obviously going to be much better at being an engineer and some people are going to be good at being an all-round architect and somebody might be a good project manager and somebody might be a good bricklayer and

O – I would really like to see everybody doing the same things and in the industry on site, there is this real thirst for knowledge – the whole of technical trades are so cut-off from

Me – so you think they really want to learn, they want to do stuff?

O – It is terrible to generalise about everybody, I think there is a sort of thirst and it could be addressed and I think it would be really really good for the industry

O – Our services engineers are King Shaw who are really really nice but they haven't done a Passivhaus before and they are unsure whether in PHPP the weather data is too positive in the winter, too high

Me – which weather data are they using?

O – The PHPP Manchester one

Me – this is one of the issues which is definitely being supposed to be being resolved – the AECB were in dialogue with the Passivhaus Institut because for all different locations around the world they will calculate special weather data so that they will use for instance CIBSE weather data... and I think we have got 18 different zones within the UK and so the Manchester one probably isn't relevant for – it is not strictly relevant for London or the South East or...

O – but the London one is even higher ... well what basically ... KK said these figures don't seem to be right we talked to Peter and he said there has been a bit of controversy about it and it has not really been resolved but it is probably a good idea to have a little bit of back-up heating anyway – it was Alan actually – so that is what is agreed and but meanwhile, KK talked to the guy at BRE and he said oh yes the weather data is complete nonsense and you have really got to do something about that and – so initially from looking at the Passivhaus spread sheet that P had done they were pretty happy with what we had got then he suddenly went into this real services engineers sort of panic which was not very good .. Which wasn't very good for the client... it's just not what you want to do with clients they want to know that you know what you are doing – it didn't matter cos we put some heating in anyway – I just thought well, I don't want to have arguments about the weather data on the Passivhaus planning package – either it is right or it is not right

Me – the last time I looked there wasn't all the weather data there for all the zones

O – I mean London is really high – I mean the worst case is +2 or something

Me – actually London is pretty warm, it depends where you take it whether it be in the centre of London or Heathrow – the truth is, I don't know where they have got to with plugging it all in but I know that it is not all there, yet the thing is you have the same sorts of arguments going on with SAP not really realising it but about all the other different components

O – With SAP you have to constantly have to give stuff back and say what have you put in and they say ooh it is just standard and you look at that and...

Me – they are not my statements (referring to q-test)

O – These are all things that people said?

Me – not literally because they are condensed into small bites but pretty much yes

O – I don't seem to have many over here – you have set us such a difficult task...

Me – now I was going to ask you – you have put up this end SAP is more appropriate as a software for low energy buildings than PHPP as you most disagree with that – would you like to say some more about that?

O – I don't think you could design it with SAP – it doesn't take into account anything that – with PHPP you can try putting things in and out and see what difference it makes and with SAP none of the things that are really important are assessed appropriately to give you a good indication from the point of view of design so although there are things like air-tightness and stuff and thermal bridges, it is a little bit you can still just change it by putting in MHVR sort of thing – there are all sorts of tricks that you can do that aren't anything to do with Passivhaus, well obviously, MHVR is but solar thermal – you can just add on renewables or you can manipulate it in a way that is nothing to do with Passivhaus

Me – what about the transparency of SAP – you said you were having these assessments done?

O – you have got to interrogate it all the time – I mean any software can be used not very cleverly – SAP too many people use it not cleverly – but even if you were really being clever, it is not a software that is designed for Passivhaus, it is a software that is designed for in the days of leaky buildings and it's just had things kind of added on to it

Me – what about up this end you have put the thing that you most agree with is that the Passivhaus standard is appropriate for new and refurbishment projects

O – Yes I think it is appropriate for everything that's what we should be doing...

Me – there are some perceptions that it is just a thing for new housing

O – It is for building and we should be building everything like that

Me – what about in your refurbishment project – they announced in Dresden that instead of allowing 15kWh per m^2 they would allow 25 because of the difficulty with thermal bridging with the existing

O – I think that is good – I am not saying that all refurbishment that we do should be to Passivhaus standard, but I think it is a really good tool for designing how much – once you know how much money you have got to spend on a building you can use it to design it appropriately and you might not get to Passivhaus standard, but you can still use the standard as a way of designing – that's what I think should be the approach – so if a housing association says I have only got £10,000 to spend on a project instead of £50,000 fine spend 10,000 really sensibly do your insulation – don't mess around with other things – which you would if you were using the Code for Sustainable Homes say or

Me – so you think that the Code for Sustainable Homes would potentially encourage you to go down a route that

O- Yes it encourages you to go down a route that encourages you to add renewables as does SAP really

Me – you have put some things in the middle – they might be things that you think what on earth is that or

O – oh they are probably just generalisations depending on what way you are standing or who you are talking about and also market is not really my speciality – how you market Passivhaus and how you get the whole building industry on side and all of that

Me – and in terms of the whole picture here would you say that these statements which are designed so that you can agree or disagree with – that they cover issues that you have come across in relation to Passivhaus in the UK? – is there anything that is glaringly obviously missing in terms of?

O – no nothing is glaringly obviously missing - the whole thing about the industry and how the industry is set up – procurement and construction and communication between people – I think that that is a really important issue and we don't – Britain has a building industry that is basically a kind of low skilled cheap product industry and turning that into a kind of more highly skilled more expensive product industry actually requires more investment than has ever happened in the industry or is likely to so I think that that is a problem – it is a really major structural problem in the whole way the industry functions and so I am maybe not really terribly optimistic about it changing in the way that it needs to – on the other hand if energy becomes more expensive then that really will be a sort of powerful driver – so I would like to see a focus on training within the industry – I think that that is something that we are not really talking about and the whole thing about communication between people in the design team and people in the construction team – that's really important and we don't do enough building physics both in architecture school and in – and every single person who works in the construction industry should do certain training in common and building physics would be one of them so that no bricklayer could go on site without knowing what the carpenter is doing or plasterer, everybody should be much more aware of the whole thing – so I think that all those generalisations are about that, they are right, that is major

Me – there is a problem with how you finance all that?

O – It is just the whole way that it has always happened it is the floor – that is how it has always worked through regulation - you have to set a floor – because if you think about pricing a job – how much you are going to spend on the building work? It's just all about how much the other person is going to put in and in terms of new housing – most of what people are paying for new housing at

the moment is the price of the land – the land is just the difference between how much people will pay and how much profit so it could just change – it is not like it was 30 year ago when the price of a new building was more expensive than the market price for a house – so I don't understand that, I think that house builders are just pulling a complete fast one actually – so the price of the land will change value – fine no problem

Me – anything else you would like to say...no...Thank you

8.P - Architect and Passivhaus Designer

P – In the UK there is a good communication between the construction trades – no well it depends, I can think of nice people I have worked with

MVHR uses more energy than it saves, well it depends if it is installed correctly – well I guess at the moment in our practice we are doing Passivhaus and everybody is going MVHR, well that is a really good idea, but we haven't actually used it any of our projects yet

Me – it is not typical, certainly not for housing in the UK at the moment –

P – And we have seen a few projects where they have been put in, quite low spec kit and in kitchens above hobs where they are just wurring and wurring... the UK has a lack of ambition when it comes to low energy buildings, it depends... lots of people have really sort of, it depends which ...

UK frightened by the degree of air-tightness – agreed

The Passivhaus standard is...

UK current legislations is ... I disagree

There is good communication between different members of the design team in the UK? – Some nice some not – we are really good at the beginning and then it just sort of deteriorates because everybody has sort of agendas, well not really agendas but

Passivhaus buildings are difficult to construct, I don't know I haven't constructed one – UK construction skills are appropriate to build to Passivhaus designs – is it alright just going quickly through –

Me - no you do exactly what you want – there is no wrong or right answer, it is not just a test of your

P - Passivhaus designs are too expensive – don't know ish

There is a market for Passivhaus designs

The UK only looks to the BRE to develop building standards – I don't know - the UK has many existing Passivhaus buildings to learn from – I disagree – our planning system supports the Passivhaus standard – I think it supports it but it doesn't really know what it is and how it supports it beyond – people associate low energy building design with on-site renewable energy – I agree a bit more

The Passivhaus standard is very flexible – when you say the standard, do you mean the energy standard or

Me – if you could design lots of different things with it

P – Cos we have been looking at future social housing projects and orientation is – cos they are new build so you think that... but with existing

Me – yes you don't necessarily have a choice whether you are overshadowed or – so particularly in the sort of urban environment

P – Yeah I agree that it can apply to lots of different types of buildings and sites, but with new build there shouldn't be a site when you are not able to implement it – but it depends in terms of what you want it to look like

Me – in what way particularly?

P – well I guess people have this sort of, whichever way it is facing it is going to have this large amounts of floor to ceiling glazing cos it is – rather than that is the north side of the building, but the least flexible thing is orientation cos you, if you are doing good low energy design you should be doing that anyway cos there are lots of people who are thinking about – so I agree

Cos we have been using the PHPP the light version where you can kind of use it before planning stage and you put in all the detailed stuff and it is quite interesting looking at – that is quite useful to flick things around and

Me – and how have you shown that stuff to planners, how do they cope?

P – well they are really interested in that – planner on the whole – they are all really interested when you go to them initially and for all the positive benefits of Passivhaus and low energy design – when it starts to get to the nitty gritty and also they are not just the person making the decision purely for themselves, they have the conservation officer coming in

Me – so the different tiers of – but where is your project?

P – In Lambeth

Me – so maybe I should speak cos I am looking for a couple of planners cos I have spoken to a couple of guys at Islington and it would be good to speak to somebody at Lambeth

P – The use of MVHR improves indoor air-quality – well I have been to all the talks that tell me that it does and really like that is really interesting like and we are talking about promoting it in our practice and I have not been in a Passivhaus ever but we are trying to arrange to go and visit some

Me – from November 12-14 there is

P – They are doing tours

Me – you can just do it yourself but there might be some people doing tours every year they have a kind of open door thing and anybody can kind of go and see their house or building or whatever all over Europe – I will send you some stuff

P – we are doing these sort of retro-fit projects, I know they are not Passivhaus but I think there is money involved in trying to achieve those standards, I think this isn't just for the client it is for the M+E engineer who is a really nice guy but there are all these anecdotal stories like if we do it like this but what if there is somebody but there is – am I making sense

Me – you are completely making sense

P – so you end up having this back and forth so no, no, no but then you hear another anecdote but you have seen graphs and you have seen data about how people don't suffocate and how

Me – don't normally suffocate

P – not normally – and we so need a practice to go inside them and then we can bring back our own anecdotes to people – you can show them information you can kind of show them a graph to sort of 99.9% but they are always more interested in the story of what about that 0.01%

Me – so the fear bit overrides?

P – so some idea of what kind of comfort levels it gives you and sort of - I guess this has kind of developed because in their house or school at the moment there is this kind of continuous movement of air through

Me – I guess they do not think about it

P – No not at all – they imagine that the room in your carriage or in your house, well that is the kind of air

Me – but they are quite happy to go on aeroplanes?

P – I suppose there are the people working on aeroplanes on the ground recoiling at the stench of sort of breathing or farting or whatever

Passivhaus buildings are restrictive for occupants – I don't think so, well that is quite linked to the Passivhaus standard is well understood in the UK – cos going to the AECB groups everybody is so into it

Me – actually were you coming back from that cos I just missed it

P – It was really really quite interesting cos

Are they understood, no I don't think so, they could be better understood

SAP is more appropriate for low energy building than PHPP? I don't really know

UK construction types are appropriate for Passivhaus design – yeah I think they are cos there is that house in Denby Dale that has that cavity wall which they have just done which is fantastic so I suppose that is a main UK construction technique but when you think of lots of framed construction like steel frame and panels and pre-fab and kind of – but when you think about German people you think of amazing high quality and you think of lots of kind of subbies doing different parts so that is sort of type of construction sort of sub-contracted

UK construction industry has a fast-buck mentality – are architects in UK construction as well?

Me – I guess so

P – I guess they are – I think they do though – I have lots of friends who are architects and they are working on lots of school projects so you work with contractors who kind of bid for projects and before that point where the contract has swapped over they are as nice as pie and then at all these points there is a kind of change in staff – one person is the kind liaison bid person and another person is the contract manager whose job it is to – so they have completely different job descriptions, roles , - so that is disagree

We understand building performance – loads of old people do! – lots of builders do cos they are really concerned about water cos they want to know if – so we are really good at thinking about water and rain and damp but we are not as good at thinking about air and heat – so I sort of disagree

The materials used to construct Passivhaus designs have high embodied energy – no I don't agree

PHPP is developed well for UK design scenarios, well I thought it was and then have you seen this whole thing about UK weather data

Me – it is probably not complete yet – I know there has been a dialogue going on between the UK and the Passivhaus Institut

P – So we came up with, those really nice engineers who we work with they had a discussion with BRE who said that the data wasn't right

Me – was that C Hodgson

P – I am not sure – so that made our engineer really nervous and he wanted to put in a sort of 30% or 40% extra capacity in the heating system and or which is fair enough cos this is a sort of retrofit and he wanted back-up but it sort of then instead of thinking generally well he is kind of doubting the tool – it is a bit worrying - I don't think he has grounds to but you can't find someone to sort of help you

Passivhaus buildings have to perform as specified to work – yes I agree

Passivhaus needs strong and coherent representation in the UK, yes I agree

We understand building energy performance well in the UK – this came out of the discussion for the AECB group

Me – I wish I had got there but I was running late late late and I missed it completely

P – well it was at 3D Reid and I found – they are a commercial practice and they have commercial clients so they think about the bottom line, so he was sort of I am trying with these clients and when you think about the sort of projects that they are doing and whether they are anywhere near sort of Passivhaus projects and is it sort of applicable and yes it is and he was trying to find some good examples of buildings in Europe and he was finding it hard sort of struggling to get into the database and he was finding that really useful, and that whole thing he had lots of figures about large office HQs and they were going to make 93, 100, 99% reductions and everybody was questioning how they sort of started and everybody had lots of anecdotes about how these sort of buildings in operation using three times more and talking about there is a complete disconnect between people doing all this design, and sort of and nobody going back to understand why and sort of learn from

Me – actually I should give them a call

P – So I don't think we do understand energy performance

Passivhaus design works well with UK building design aesthetics – when you look at all the German and Austrian projects, they look German and Austrian but they are the only examples you can show and I think there is a kind of mix up between what a Passivhaus looks like and cos it can look like anything and what a kind of German or Austrian building design is like – I think it could it should with not like minimal all like the modernist guys

Passivhaus designs are future proof – as in terms of overheating or

Me – possibly well there are lots of bits that you could say

P – I would like to know more about all the kit that goes in – I mean the fabric is and you make sure you have the thermal mass you can do all these things the kit is all like designed for – and all this thing about the ventilation system has to be finely tuned and you need to get that serviced every year and probably – maybe

Passivhaus components are affordable in the UK – well the kit is still overpriced

The UK responds well to the Passivhaus German language product – I don't think so – people in the UK are terrible about looking elsewhere and thinking that

The German name Passivhaus is appropriate for the UK market – I don't think it is the German name but having house in it has confused lots of people but it is really good to have a sort of branding – if you changed it what would you change it to and what would be

UK design skills are appropriate to build Passivhaus designs – they don't need much to get there I am quite optimistic

There are financial incentives to build Passivhaus designs in the UK – I think in terms of the life-cycle of the building and fuel costs but no other incentives that I can think of – we understand how to detail buildings well in the UK – is this what people agreed at the focus group

Me – what they are they are covering a whole range of things that were discussed and they are just written in a way that you can either disagree or agree

P – so that if you are kind of detailing for cold bridging and air-tightness but that is not keeping the rain out cos they can do that – kind of a zero maybe

...

But Scotland has a really strong cos all the events I have been to in England they talk about the Swedish the German and the Austrian they don't mention they say isn't it terrible we haven't got any UK – yeah they are always saying British Passivhaus projects going ahead, but there is quite a lot going on in Scotland and there hasn't been that exchange at all

Me – that is the AECB do they have much representation

P – Much representation in Scotland – maybe they don't – there are lots of people up north sort of – there could be a really good sort of information exchange

Me – and you don't think there is?

P – maybe there isn't, I don't know cos the AECB are very much about – I mean they are very good at being open like with their details and free information etc. – and I have been going to several events like the retrofit for the future – people are into Passivhaus but they are quite protective about it in a way, cos they see it as a kind of commercial advantage being up on it which it is I suppose – there is always a kind of naturally competitive nature involved, they are being quite secretive about which is quite

Me – their unique selling point?

P – Exactly – but hopefully if everybody builds to Passivhaus standards then – so at the minute I think there is all that kind of stuff still going on

Me – I think that that is probably true

P – And PHPP is developed well for UK design scenarios, I will put that as a one, because it needs the weather data to agree on but that is the only reason it is a one

Passivhaus buildings are restrictive for occupants – I don't agree with that – because of all the hot weather we have been having recently there has been articles about shutting windows – that is such a Mediterranean attitude

The use of MVHR

There are lots of Passivhaus details where it is all about sticking quite nasty stuff really – we are all for using more

Me – yes I was looking at some windows being installed and all the adhesive and insulative foam that you might put around

P – So relying on that cos construction projects take ages to get off the ground

Me – it's the price at the end

P – As long as we start developing stuff over here – lots of people have been installing those Ventaxia – but they haven't been through all the tests and they are not honeycomb heat exchanges so it is all – I think there is a lot of people who need to be educated in what having an efficient MVHR system is – what it actually means

Me – we understand energy performance well – disagree

P – The materials used to build a Passivhaus design have very high embodied energy – did somebody say that – well that is not right

UK construction industry has a fast-buck mentality – well design build does, that bit is design build if you tell the contractor that he has got to build it to these minimum flaky standards then – there needs to be a lot more – but design build would be fine if at the requirement stage there was a really tight document and they weren't just a set of planning drawings and code levels – something much more descriptive – so it's not their fault

Passivhaus is too expensive – well they are too expensive at the minute for people to re-construct but they shouldn't be – well you should be able to take up the slack

SAP is a more appropriate software, that is a disagree – I disagree

There is good communication between different members of the design team – minus one,

We do have ambition we just have a lack of skills to bridge it – so that immediately gets people kind of disengaged and

Apart from the ventilation system and the triple glazed windows – they are the pricey bits everything we have in the UK is –

Me – but if you wanted it swanky would it come from the UK?

P – With all the materials with all the supply chains that we have got over here – with a kit of parts you should be able to get there – so maybe I don't strongly disagree with that...

It is really hard cos I haven't got that much experience from building it – like Passivhaus design is really flexible – like I want that to be really true and I am sure it could be and is but then maybe this is my kind of little UK blinkered – I do think they need to perform as specified to work – definitely and that is quite different from how the UK has been going on getting on with low energy buildings – because you hear all these people about telling these shocking stories about these uber green buildings and actually – they are quite gleeful when they talk about things like BedZed and it all went wrong because – and you do find that in the academic sphere as well – then when you talk about projects it's all about telling you what you did wrong – which needs to be done – but it is also quite important to tell what you did right and what was really good and taking it on for next time

Me – do you think there is this kind of mentality when – like a general negative attitude – in that we are not encouraging enough? In understanding when something is new there are going to be eggs broken?

P – definitely – it's like when you flick through AJ magazine or something there is a collection of architects – and they really quite revel in picking things apart – which obviously being critical is really important but not just saying or being negative

Me – where do you think that comes from? Does it come from education or does it come from our culture generally?

P – I speak only from an architectural perspective – you do your design project, you pin it up on the wall – I mean it is called crit – I mean be critical and so you are very lucky if they tell you something they have done that they are impressed by

Me – so you think in those situations they will zoom in immediately on negative stuff

P – well there is a way of talking about something negative but in a positive way – well you could improve this by but not kind of – so when you read all these stories about low energy building and people installing biomass boilers that don't work or that – I think there is something in that that it creates a kind of negative attitude

Me – so you think that people think that that is the way to analyse or criticize to start with rather than building up the strengths?

P – So it does make it very hard to talk to clients and builders and other architects about – again it is about fighting all these anecdotes

Me – you and or O were saying about the 0.1% failure and everybody will dwell on that rather than looking at the 99.9% which is actually positive

P – I think that lots of people are really excited about it and in terms of talking about being positive about things, I think that they are ready to adopt it but they don't know how and they don't know how to afford it – and there all these little negative anecdotes and a lot of people are waiting until other people...

I mean UK building design aesthetics are kind of out of town shopping centres

There is that page about how heavy weight is your fabric but you can get the MVHR to turn to cool – also there is Bill Gething who has written a report that says he thinks that MVHR will be irrelevant in the future because the heating season will – because we won't have any heating season – because the kit is so expensive at the minute thinking about the MVHR, I am thinking about the – I could do with someone kind of saying you are saving this much with that or – so you need MVHR if you have air-tightness designed to 3 but how do you design to like 3? – All we can do is to try and design to zero cos

Me – yes that is really weird that trying to design to 5 or 3 or the new building regs

P – So if you are designing to 3 you have to near zero and allow for trickle vents – so you can kind of see it as bit of a waste putting all this energy in

Me – what do you think of the overall spread of statements – how well does that cover the issues that you may have encountered

P – There are groupings of them which are all quite similar – there is quite a lot about detailing, there is a good procurement

There reason we haven't got many Passivhaus developments at the moment is because we have been quite slow to pick up on the whole movement

Me – why do you think that is? Why have we been slow?

P – I am not really sure I think we are quite in the UK we always seem to think that we really know best – I mean the Government had their zero carbon for 2016 and they didn't kind of mention Passivhaus, I don't know if anybody had this kind of discussion – Passivhaus doesn't meet that because it is a much more controlled and measured kind of route to low carbon and this whole kind of push to micro-renewables which everybody got completely side-tracked with – and now since

1990 there is 20 years of data and people are kind of like getting well if it does work over there then it may work over here

Me- so at the other end, you had trouble kind of finding your most agree with one?

P – it is pointless building them if they don't work as specified – there definitely has to be more of a link between the day that the building is finished and a year or two after – for architects there is a section in Part L where you are supposed to get user feedback but nobody has taken on really – there is a bit where the contractor has 12 months and goes and does defects – it would be great if there was more communication between the design team but often the users a few steps below the client and ...

Clients

9.AA – Passivhaus Client and Passivhaus Designer

AA – the German name Passivhaus is appropriate for the UK market – gosh that is a hard one – me I am biased towards, I haven't got a problem with the name – but I don't know

Passivhaus standard is well understood in the UK – I strongly disagree – the UK responds well to the Passivhaus German language product – I possibly slightly disagree with that – we understand building fabric performance – I slightly disagree with that – there is a market for Passivhaus designs in the UK – well I hope so – the materials used to construct Passivhaus designs have a very high embodied energy – well my answer is that they can – they don't have to – Passivhaus buildings have to perform as specific to work – I don't agree with that because they can function as a building

Me – but to function as a low energy building? –

AA – I slightly disagree with that – Passivhaus buildings are restrictive for occupants – I disagree with that – there is good communication between different members of the design team in the UK – based on conversation and anecdote I would probably say no – we understand how to detail buildings well in the UK – again no – UK construction skills are appropriate to build Passivhaus buildings – I strongly disagree with that – there are financial incentives to build Passivhaus buildings in the UK – no there are not – if someone can tell me about them, I would love to hear about them – UK current legislation favours Passivhaus design – no not as far as I can tell – Passivhaus designs are too expensive – well they are at the moment because it is a niche thing – so it is not intrinsically too expensive – so I am going to say slightly disagree – there is a mature supply chain for Passivhaus components in the UK – no – UK design skills are appropriate to design Passivhaus buildings – no they are not – the UK Government looks only to the BRE to develop building standards – it probably doesn't look only to the BRE – BRE are probably very dominant but not the only ones – Passivhaus needs strong and coherent representation in the UK – yeah I would agree with that – Passivhaus is appropriate for new and refurbishment projects – well definitely the new, I am not sure about refurbishment – the Passivhaus standard is very flexible – well yes – there is some flexibility there – it is not very flexible it is a bit flexible – Passivhaus components are affordable in the UK – yes – People associate low energy building performance with on-site renewable energy technologies – yes they do, I would agree with that – The Passivhaus standard will only catch on if major house builders adopt it – yeah I suppose I agree with that – we understand building energy performance well in the UK – I disagree with that – MVHR uses more energy than it saves – I disagree with that – PHPP is developed well for the UK design scenario – what do you mean by the UK design scenario?

Me – the way we work in the UK

AA – I slightly disagree with that not with PHPP but

Me – well there are certain things about PHPP – the way you put measurements

AA – the conventions for measuring floor area – yeah it doesn't fit in the UK conventions

Me – but it also relates to design team processes and things like that

AA – Passivhaus designs work well with UK design aesthetics – now that is a very good question a very good statement – I don't think we really know yet – I think I slightly disagree cos there are definitely issues there – dormer windows and all that – our planning system supports the Passivhaus standard well – no it f***ing well doesn't – Passivhaus buildings are difficult to construct – yes in the UK context they are because we don't know how to do it – SAP is a more appropriate design tool for low energy building than PHPP – I strongly disagree with that – People in the UK are frightened by the high degree of air-tightness associated with low energy building – I would imagine that is true actually – in the UK from my own conversations with people that is reflected – In the UK there is good communication between construction trades – probably not – Passivhaus designs are future proof – I think they are – UK construction types are appropriate for Passivhaus designs – are you thinking cavity wall etc. – well Denby Dale has shown it is possible to do but I don't really agree with the statement though – I think it is more to do with – it is possible but it is not really appropriate – appropriate is not the same as possible – the use of MVHR improves indoor air quality – I agree with that – the UK has many existing Passivhaus buildings to learn from – no it doesn't – the code for sustainable homes is a better standard than Passivhaus – the UK has a lack of ambition when it comes to building low energy buildings – yes it does –

The code for sustainable homes – is it better well no not in terms of energy but it covers more things – it is apples and oranges you can't really compare the two things – I am going to give that a minus one to reflect that – does the Government look to the BRE well I don't really know if it does or not – do we understand building fabric performance well in the UK – well I suspect we don't so I will give that a 2 – there are financial incentives to – well no – UK clients are ready to adopt Passivhaus design – I don't know – we understand how to detail buildings well in the UK – well we don't – Our design skills – what are design skills

Me – well you are sitting in front of one for instance

AA – well this architect that I spoke to in Totnes who had a lot of misconceptions about Passivhaus – but I am sure that if he knew more about it and was open to the ideas, I am sure he has got design skills – UK construction types are appropriate for Passivhaus designs – some are and some aren't –

Me – can I quickly ask you – you put as the one that you most agree with – Passivhaus designs are future proof – I am asking why you have put that one there

AA – I suppose for me that has been quite a driver behind my own choice with my own house to do a Passivhaus – because I want it to work for the rest of my life and really and the kind of future that I see – which is described quite nicely in this book here – a kind of steady de-industrialisation over the next two centuries – I think that Passivhaus should outlast its contemporaries and be useable as a building longer so I suppose that is why –

Me – on that end on the minus level you have got that UK construction skills are appropriate to build Passivhaus designs – why have you put that in there –

AA – because achieving a Passivhaus is all about detailing correctly and attention to detail and everybody on the site understanding the importance of air-tightness which people don't so maybe it is sort of knowledge and skills and the fact that we don't have a proper system of apprenticeship and training for all the different trades – for many of the trades – so you can't really be sure that you are going to get a minimum level of knowledge and skill – particularly in London where there has been an historic pressure on the trade to deliver buildings – it is interesting down in Devon we have to go with what skills are available because the economy is not so strong – again all these opinions are based on anecdotal evidence – that is my impression – based on all the information that I have received –

Me – this is about your perceptions – and up here you have also got about our planning system and you have got that down

AA – yes that is because I really feel strongly that because I am going through the planning process at the moment and I have seen in practice how the planners look at how well a building looks in keeping with its surrounding – and that seems to be the pre-eminent criteria and all other criteria seem to be

Me – so what it kind of looks like?

AA – yeah – and not even whether they like it but whether it fits in with what is already there – so there doesn't seem to be anything else that can weigh against that – if it doesn't meet that criteria then nothing else really matters so it seems to be the tail that is swinging the cat – I understand that in Belgium the planning system is much more relaxed and you end up with more higgledy piggledy streets and maybe we should be willing to accept a more higgledy piggeldy landscape – the planning rules need to be there to protect people from losing light and – but on the aesthetic side maybe there needs to be a looser arrangement – and when you start looking at low energy design you want to start to re-orientate your roof in the optimal direction and our case we have been told explicitly that we can't do that because it is not in keeping – we have no choice if we want to do the project, we have to have the roof in a non-

Me – are you building to Code as well?

AA – well we are not going to get to code level 6 because of the water side and I actually feel that even more strongly after having experienced a reduced flow shower head – I just thought it was completely rubbish actually - it is hopeless actually you might as well get a bucket of water and I am not into reduced flow showers – but I am into because it is our own house because as users we will definitely get toilets that will not drain an entire reservoir each time you flush it and we will get a triple A or double A washing machine – for my shower my means of controlling water use will be controls that you can switch on and off during your shower – rather than low flow – so you can have full flow when you want it and low or less when you don't need it –

Me – have you presented any PHPP calculations to planners – are they interested?

AA – they have shown about as much interest as if I had shown them my holiday photos – in the design statement I have explained what PHPP is and I have given a statement as to what PHPP is – and how the changes we are making to the outside of the house where they are needed to achieve the standard –

JC (was sitting nearby AA – JC is AA's architect) – we found a planning brief – somebody has done a planning brief

AA – the planners complimented me on the quality of my design access statement – they thought it was very well written and helpful for them – but it didn't appear to change – we have submitted initial plans and we have been told that they are not acceptable – and we are now in the process of revising the plans but because we have done a lot of detail work already and because we need time to think through all the implications of the change and also because we are using the change to try and build in additional benefit that we are – to try and counter balance the extra cost of the new design and that is taking a little more time so we will submit that around the middle of next week

JC – they are allowing us to make these changes within the current application

AA – yes –

JC – so they are trying and have said that if we make this particular change then we will fully support it

Me – what is your planning authority?

AA – it is South Hams it is in South Devon – but the thing is they have done it within an existing application because that is an entirely different thing to minimise the effect on their central Government targets because they have already overshot their 8 week target on and now because they have had to ask me to redesign that is the reason that they can give an explanation why they

haven't met the target because if this one was left and we had to do a new application that would look worse on their target- that is my cynical explanation of why they are

JC – I don't think that is the case they could just flatly refuse to speak to you

AA – yes they could – and they haven't completely said that the whole thing is rubbish and because we have had a lot of support they have seen that it isn't just my little egocentric project

Me – is there anything you would like to say about the middle zone?

AA – well a lot of the ones that I put in the middle I have put in because the question and the answer is it depends – the statements are sometimes true and sometimes not the statement is true if you design it incorrectly or if you have a leaky building – if you design a Passivhaus properly it will use a lot less energy – UK construction types – well some of them are some of them aren't – I am thinking of the ubiquitous and not terribly exciting Dormer windows that you see – the PHPP is developed well for UK design scenarios – I suppose the main thing that I am thinking there is I am not sure what is met by that statement – but the main thing with PHPP is that it forces you to do a lot more up front design work than you would normally do before you submit your planning application so because of the way the planning system works not many people are going to want to spend much more money than they actually have to until they have got some certainty that the project is actually going to go ahead – I have actually had to take a big risk and spend a lot of money before it is going to happen and I don't think I am a very typical guy in my willingness to do that – it is not the PHPP it is more the fact that the whole Passivhaus design process forces you to do that up front – but I think that is a good thing to do more detail work up front because that means you have less risk of project changes later on when it might cost more – doing more detail work up front allows you to reduce the risk of project time and cost over-runs – the UK responds well to the Passivhaus German language product – I don't know if you think about the German car makers they often play on their Germanness to convey certain ideas – Britain has a rather stereotype view of Germany – this is slightly off topic but most people in Britain don't seem to understand that life has moved on since 1945 in Germany and there has been a bit more that has happened than the Nazis in Germany – Passivhaus has to perform – I am not sure what that really means so that is why I have given it a zero – and the UK clients are ready to adopt the Passivhaus standard and I think some are – a few might be – in the same way because there is a lack of knowledge in the construction sector there is a corresponding or possibly even greater lack of knowledge in with potential clientele and that is changing rapidly – I would have given that more of a minus score if I had had more space – otherwise just looking around, about the financial incentives to build Passivhaus designs in the UK – there are no central Government incentives there is nothing like that, there are no planned policy incentives but I guess that anyone who is prepared to sit down and do the number crunching and who is prepared to take a longer term view of their bills and whole life building costs and their view will see that there is an incentive even

though there is a higher capital outlay – it will pay for itself in terms of reduced energy costs and lower maintenance – Passivhaus designs are too expensive – again that is, it depends – I think it would be an interesting experiment to build a Passivhaus that actually costs the same as a comparable non Passivhaus – I am sure that if you used standard components and if you cut back on other stuff – that often clients rip out anyway and replace with their own stuff, you could probably bring the whole thing over to the same – a helpful planning context as well would, and if you had a client that was willing to forgo the gold-plated bathroom taps and go with the proper certified MVHR instead then

Me – are you going to be using gold taps in your house?

AA – I am going to be using Hans Grower German taps – because you buy the tap once and I want the tap to outlast me

10.BB – Passivhaus Client

Me – you are pretty pioneering trying to do this project – you are the first guys trying to achieve a retrofit Passivhaus

BB – well if you think about it – if you think of this street – if you came back in 100 years' time do you think this street would be any different? What we argue is that there is a modern 60s block there and that may well have gone but most of the other stuff will be there and – what's that MVHR?

Me – Mechanical ventilation with heat recovery – that is for the air supply

BB – this is not a very good model is it?

Me – in what way?

BB – it is too much information and you are probably persuaded to make decisions without having thoroughly thought them through

Me – take as long as you like – some people do take quite a long time

BB – I am sure there is an element of psychometric in here

Me - yes there absolutely is this is actually used as methodology in psychological studies and socio-political studies – the thing is they all end up being relative and relative to the whole set

BB – I am getting funding for this one

Me – who are you getting funding from

BB – the retro

Me – oh the TSB

BB – there was a competition – but how we got it and what it is worth is not 100% by any means

Me – would you have done it if you hadn't got that funding

BB – No

BB – I don't think we have got at all the right skills from what the contractors tell me

Me – did you have any problems finding contractors?

BB – no because the specific team now...

New person – what are you doing.... interest in our project has been mushrooming we have had to have 6 or 7 tours now – it would be good if Marion and Phil did the test

Me – are you happy with that as much as you could be

BB – as much as I possibly could be

Me – at this end the one you most agreed with is that Passivhaus standard is appropriate for new and refurbishment projects – do you want to say anything more about that?

BB – given what I am seeing out there it is clear that there are – and at this time of being an experiment – I am seeing stuff that I am walking into and I am a building surveyor a chartered building surveyor and I am looking at that and I am thinking it is not too complicated actually – it is good sound technology, build it thick, use the heat that you have got – I can deal with that and I have been dealing with condensation problems all my life and I can understand getting the heat and recycling it instead of just throwing it outside which is bad news – heat it up and send it back in – it makes sense – I certainly think those standards are appropriate for new and for new build quite easy actually, it is not going to be terribly difficult – if there were reservations they would be about the fact that you need density – if you said in the UK that would be different

Me – why?

BB – in London, space standards they are pathetic – I have just come back from America and if they could be bothered to be interested in energy

Me – you have also got that Passivhaus standards will only catch on if the major house builders adopt them

BB – well there will not be a lot of public funding into house building in the next few years so who is going to be driving the new build – there has to be a buck in it, if they think there is a buck in it – I guess I am thinking here we have an ambition to reduce energy costs – I guess if I was running a 4 bedroom house as an energy bill I must be talking £1500-2000 per year easy – I am potentially looking at £200 per year – now that is if I was marketing my building that is do you want to spend 2000 on this or do you want to spend ...but the investment costs for the developer is the bad news – my problem is with looking after stock and believing in our need to improve our energy efficiency and there is an argument that I have choices to make – I can repair roofs, I can invest in this wonderful technology – roofs get me, I have problems with leaking roofs but their energy bills are high – so my priority at the moment is building fabric – my residents tell me that the bills are going up and we want lower bills – but I have to invest on a very low level to give you that return and you get the return, I don't get the return, why can't – I know there was a white paper – why can't the energy companies say well I know it costs you £100 per month from an energy point of view – if you were to put some dry lining in, if you were to put some double glazing in and an energy

efficient boiler, it would come down to 50, how about if we were to lend you the money to do it and charge you £90 a month? You are £10 in and over time you will pay back the loan and everybody is happy and with the way that the government works today the more they will look for industry/energy companies to do that rather than the government – people like me a social housing provider can facilitate that but I don't have the money and I can't borrow it under normal circumstances

In one way that is actually putting your money where your mouth is – and with Passivhaus the data will one day support that – it is a no brainer, it works then it makes sense for people like English companies to do it - that would be my feeling

At the end of the day with people it is their money –

Me – you have got PHPP is developed well for UK design scenarios

BB – I am simply making the point that I am only looking at retrofit – the guy we had there earlier Edward, he is project managing on this – actually my development guy my developer they are doing a Passivhaus down at Shepherd's Bush – very different – they have all been across to Germany and possibly you can't buy the book well you can buy the book – and you can get it modulised and imported but not in my environment

Me – there is obviously more existing stock where there is an energy issue

BB – absolutely 70% whatever the figures are – the level of new build is decreasing and will be decreasing – if energy is this big issue which it is – a colleague of mine here looked after Pimlico district heating and he was saying that actually when they did the calculations when they were refurbishing it he is now quietly embarrassed because the price of gas has dropped significantly and all those calculations and all that worry about why it makes sense to do this go out the window. Now he thinks that that is for some time – we don't really know – America get the hump about some issues in America and then there is not drilling and then there is another oil crisis going on – we don't know what their dynamics will be there is an argument in Russia – I mean someone suddenly invents something that is highly efficient – if that happens Passivhaus market would close tomorrow wouldn't it – if energy was cheap/free there would be no Passivhaus – I recently come back from America, Florida and that sun they get - the heat – can you see a solar panel anywhere? I mean photovoltaics very expensive but proven – payback no good – but solar panels, hot water free? You know how they shower like and they haven't picked up on it – wow! But the payback works on that property there! – that returns 80% of our hot water – that in a British climate – it would more than make up for it in an American climate – unless the cost of the energy they are paying is so much lower than we are paying and potentially that makes it complicated

Me – I don't know exactly

BB – but Americans can make a buck, they know how to make a buck don't they, they are very good at that they would see it if that was that – but if you go over to the Caribbean then there is a lot more solar panels on those houses – if you go to Jamaica you will see solar panels – self-made panels in a lot of cases but you will see – but they get it because energy to them is very expensive – it is that dynamic – that is the economic dynamic – no-one's doing it for global warming – in a funny way they are the pioneers of it but it isn't that which is going to drive the population with it – at the end of the day it is money isn't it

Me – the things you have put in the middle are these the things that you...

BB – I don't know, I don't know

Me – in terms of the general spread of statements – there may be other things that you can think of that are not kind of represented here or do you think that these are representative of the type of issues?

BB – of relating to Passivhaus? – you have got nothing about political views things that will drive it are politicians I am afraid – when politicians often make things happen they will influence for instance the contractor over there by offering subsidies – they will influence by affecting building regulations they will influence by public sector housing funding – which to a degree they do which they will do for sustainable – you have the code in there somewhere – what they do not specifically do is say that this is an adopted standard and I am told that – I mean I don't know – but there is a conflict between the two standards – but then I have conflict with SAP, I think SAP is a dreadful standard you put in a boiler in a barn suddenly your SAP shoots up by twenty points – it gets like BREEDEM what is the other NEC one – but I am not a clever person in that regard, I don't understand what's happening unless it's very simple – and if I don't get it and I am meant to be a professional how do you expect Jo in the street to really understand it

Me – is there anything else you would like to say about this?

BB – Passivhaus is based on a very sound set of principles – put an extra jumper on – put an extra jumper on that house it is a very sound principle and if you do that you are saving – there has been a diversion into new technology – the windmills, the panels

Me – yes I noticed that towards the plus side you put that people associate low energy building design with on-site renewable energy and not fabric performance

BB – yes I agree it is – if you said to me energy efficiency, I guess most people in the street would say double glazing, solar panels blah blah blah, that is what they now are almost educated to think that that is what it means but the whole point is you don't want to be generating the need for energy for the home – it is classic Passivhaus it is exactly what Passivhaus is trying to say – I

guess I get that and I would love to do the same on my house – my wife would have a right go if she suddenly came in to two metre walls

Me – the only other thing I was going to ask you about quickly was just the air-tightness thing and people being frightened about that

BB – I agree that they are frightened about that – yes absolutely

Me – have you spoken to your tenants about that sort of thing?

BB – I guess I am just trying to think about one of the things that we have discussed when we have talked about this project and who is going to live in it is the dynamics of do people like air and I am probably slightly biased in the sense that I know from systems where people do not have control over – they try to take control and then these systems are systems where people will not have control over – it is a managed environment and now I managed stock with the Pimlico district heating system and we would go down there in the middle of winter to Chelsea Garden Estate and it is a lovely estate, one of the best council estates probably in the world you know it is really fantastic – lovely district heating system but no control put in the flats so they just open windows and I think there is an element there with – that people may muck up the entire basis on which the design is developed and suddenly all this air that is supposed to be recycled to keep you warm will not be there any more it will go out the door – they don't get it – or may not get it – so they will have little electric fans to plug in at certain times of the day and the BEDZED is an example of that – but in a sense is that a failure? You are talking a few kilowatts of hours – is that a failure – it's not really a failure, it is part of the experiment – the experiment isn't just about the building it is about the people and that is why the study is quite interesting because we want to study the occupants and select the right occupants to study over two years and comparing it with the one next door – I don' t know if anybody said but the one next door is ours as well – we are going to refurbish that – not to the Passivhaus standard but to a decent homes + standard – across the road I have another building we did that three years ago just to a basic standard and we are monitoring all three and that is a real experiment – that tells you not just about the building but the people in the building and people are different so you have got to allow for that – I think that is part of the reason why we got the grant I think it is a real good experiment – we all know about decent homes standard in terms of energy but it is not much of a change I mean 50mm of insulation – whoa hey I mean blimey – so we've got an opportunity really to see how that does deliver me a £200 energy bill a year – my residents all want it and I can't give it to them, that is the – so the conclusion would be maybe that that proves it is possible if you invest and the real cost isn't the odd 70,000 on the quote the real cost of that is probably nearer 50,000 the rest of it was that you take the building in its initial state and you have to repair it and that would have to happen anyway and not all of my buildings would have that – is that something that is affordable that I can get payback on

Me – have you ever been in an actual finished Passivhaus?

BB – I have seen Kevin Mcleod talk about them and show them on the telly but no I don't think I have seen one – they guys have – Lewis has – they went over to Germany and Sweden and I have probably seen them from outside when I have been to Sweden and Norway and Germany but I have never actually been inside one no -

It seems to be that on the continent people who do something are classed as an engineer – here they are an operative trade person and they are – and you get that back – you don't stretch them and because they are not stretched they don't give you a lot more – I don't know if you watched that great thing on TV last night – go to Channel 4 and watch it a guy from Best Weston, the Chief Executive did an undercover – because one of their hotels had failed and behind the scenes he said – he spent a day or so with the maintenance men – it was terrible, what an endightment of the British work force – they were going to come back and inspect this room and the sills need doing on that and don't worry about that we will change the door numbers over – when he turns up he will turn up at number 50 again and it will be ok because 49 is ok but it will be 50 – and I will say that we don't do ourselves any favours – there are dynamics behind it about why and but in a sense if the world were to blow up and we were all stuck on a desert island, these are the one-eyed gods because they can do something with their hands but we don't – these guys are really precious but we don't seem to recognise it for some reason, particularly in this country I think and there is a question you have got in there about the skills and the skills aren't there – when you go and see the guys working on site and I did, you will see these little sticky tapes put up everywhere – they are to keep the drafts out – it is critical to the design – you would be hard pressed to – if you go to any traditional house and you start taking up the floorboards and you start looking at the amount of newspaper wrapped and stuffed under bits and pieces – I mean the 60s developments and the towers – why I don't know, I don't get it – I don't know why this is so and I come from a background of builders, my father was a carpenter and his brother was a master craftsman and they were really good but there is something that is gone – my feeling actually is that the construction industry on the continent has taken on more of an industrial base – a manufacturing base and we haven't got the training

Me – that certainly seems to be true with research done comparing the UK and German construction industries

BB – but our buildings aren't designed well to enable our guys to do the job properly – things like this are really good when you look at Passivhaus package and you see it all created it is so neat and tidy and you understand that it is a manufacturing industry – we have made it something different but it is so easy to be made in components that could actually fit together quite well and done in proper environments not in these exposed environments that we expect our guys to work in

11. Z – Passivhaus Client

Z – I agree with the bit that most people don't know what it is, so that goes here – it is a fact – we built up a very good relationship because we were the first and I think that they found us interesting and perhaps even exciting – yes we have to be future proof because otherwise we couldn't survive – I agree it is not understood at all – I told you about the planning department – no they are not difficult to construct – that is a load of crap – no they are not too expensive – they are expensive but it's like for disabled people you buy the best you can afford or the cheapest that you can get and you end up spending the same, but with the one you get something that will last you 40 years but with the other you will get something and you think shit why did I do that – I always explain to investors who come here and I say, you have got a choice – for the money we spent we could have 5000 sq. feet of the best that we could afford or 8000 ft. of crap – no they are not too expensive –

The code for sustainable homes is that BREEAM – no BREEAM is a pain in the arse – it is tick box ticking, job creation for academic know-alls – it is an absolute waste – I don't think it is appropriate

We did a paper on getting disabled people back into this industry because there are 156,000 construction workers out of work in the east of England who we would like to re-skill but we could not find one sponsor to pay to have the course accredited so that we can deliver

Me – what about the regional development agency?

Z – No they tell us to go to ERDF

Me – and they say?

Z – and they are being abolished the Construction Industry Training Board has no money – so we are ready to go and we have a building to show – a thing that is ready to teach and a product that works and a charity that is accredited to deliver to NVQ3? – We have a 156,000 reservoir of people who could turn into people who could work in this industry so we don't have to bring in people from Lithuania and we can't start

Me – is there anything that you think that could solve that?

Z – a conversation with the Prime Minister – simple you go to the top – it is only when we threaten questions in the House of Commons that – to name officials in the House of Commons – they shat themselves and what happened is this – the Lord Lieutenant just let it lie fallow at the end of a conversation that if you thought that at the end of your public career there was an OBE waiting for you, remember who endorses your application and I am the patron of the charity – no threat there – I have been a skunk in this, I am not proud of some of the things I have done

That I don't understand

Me – some people think that there are certain ways that buildings should look in parts of the country like for planning and that a Passivhaus might look completely different from our UK

Z– I disagree with that – the German name Passivhaus is appropriate for the UK market? Well why do they have a problem with Mercedes Benz then? – buy British, throw the foreigners out except – is that your Merc over there no is that your Peugeot?

I don't know what SAP is

Me – I wanted to ask you why you have put our planning system supports the Passivhaus standard well at your least agree with end of the spectrum?

Z – this is the 14th site we had come to and we would still be going if the county council hadn't sold us this site – we have been blocked by Chelmsford, Braintree, Colchester and Brentford – in Chelmsford we were blocked on two sites, the leader then offered us a site by the canal near a Victorian pumping station so that this eco-centre would be next to a Victorian pumping station and an area where kids could come and see a canal, yesterday's technology and today's technology and we could use natural gas from the sewage farm as a heating element – and that was refused by his own chief planning officer

Me – why? That sounds like a very good site potentially?

Z – The planning officer considered that it was too early to introduce this type of technology into the green built areas around Chelmsford

Me – at this end of the scale you have put the thing that you most agree with is that the Passivhaus standard will only catch on if the major house builders adopt it – why do you think that?

Z – the successful have success – the strange thing about the English is that they are actually frightened of innovators – they tell the world that they are proud of their innovative history but they are actually frightened of them – and if you actually look at the antecedents of the great innovators – they are all from the Celtic fringes – that is not a racist remark that is a cultural remark – just as the Palestinians and I have worked a lot with the Arabs, the Palestinians are probably some of the most innovative and lateral thinkers you will meet in the Arab world because the only way out of the mess they are in is through education and innovation – there is no natural material there is no oil wells there is no wealth, farms, fields or anything – the only way out of the mess is between the ears and for countries that have always had a tradition of having to live from nothing, the Norwegians, the Celtic fringes – there is a great tradition of welcoming and recognising innovation and seeing failure as part of the process of learning and not a failure to be derided – there is this peculiar English problem and I think it is cultural – and the industry I have come in to – I didn't chose to come into this industry is where people have to innovate to get out of where they are and as with everything, I try and show that with an analogy – if you picture somebody going in a

wheelchair up to a slight ramp in the ground towards a ramp that opens towards them and then you invite them to open the door, with the left hand they probably break on.....

Me – one last thing about this – what do you think about the general spread of these statements

Z – fine – I don't understand some of the statements – I am the client it is our money that pays for architects to build what we will use for sixty years, conveniently forgotten in the welter of that technical jargon that they all had at that presentation – and I did say and it was perhaps a bit catty but that this short, fat, bald little old man pensioner pays your wages – so the flowery handkerchiefs and the expensive hand-cut suits and the nice shoes may be nice to show off to the corporate bosses but it is my money that is paying the wages and it is occasionally humbling to remember who pays your wages – the industry I was in we never forgot who paid our wages – it was the passengers so we tried not kill them

Policy Advisors

12.PP – Policy Advisor

Me – are you happy with that

PP – as far as I can be – I could keep fiddling with it and there is lots of it that I know I don't really know cos I am kind of winging it –

Me – I am really interested in what you put at either end – like at the plus 5 end you have put that people in the UK are frightened by the high degree of air-tightness associated with Passivhaus – would you like to say anything more about that and your experience of

PP – I think that there are a lot of thoughts about bad air quality and condensation and all of that kind of thing and that fresh air and ventilation and those kinds of things, particularly in terms of social implications and I think there are quite a lot of people associating that with poor social housing and old stuff that doesn't behave very well and asthma and lurgies so I think there is an element of that and there is also even though air-tightness isn't the right perception – there is a general feeling of stuffiness in homes that have smaller windows so whether that is for air for energy efficiency or as a lot of newer homes have achieved those design standards by reducing the size of their windows – then you get dark stuffy homes or because they might be very old homes that traditionally had very small windows – there is a sense that that makes it generally stuffy – so I think there is issues of that and the need for fresh air

Me – at the other end – what have you most disagreed with?

PP – there is good communication between different members of the design team – a whole raft of both personal and professional background in that – the last thing that I worked on for the Technology Strategy Board was to do with design techniques so in the course of that and separate work that I have carried out in relation to design information and the collaboration on the creation of design by different members of the team – it is very easy for things not to work practically – for the communication not to work well for the design intent not to be fully understood and you haven't kind of got the same kind of ethnographical model that you have in a normal engineered product

Me – do you think buildings could ever be anywhere near what you call an engineered product?

PP – they can and they should be in many cases and I don't think that that is inconsistent with being flexible and robust – our approach to product design is very much that when you design any product you – sort of a mobile phone or whatever it is, you design it with a view to the way that it is going to be used and we don't do that well enough in our homes – and in other products we have a very good knowledge of the range of ways in which things might be used, we go in and we look at

the way they are being used and research the way users are using them and feed that back into our product design and we do that in a very ad hoc, ill-informed way in housing

Me – why do you think that has happened in housing and buildings?

PP – it is a sell and forget mentality, it is because land is more expensive and valuable than housing on the whole – so if you look at anything in Germany for example and if you look at all the market for self-build or self-procured homes in many other places – people buy the land and then they procure the home – so the home is product and then is selected on the basis of the attributes of that product rather than in the UK where we tend to just need to buy the location and the house itself is a kind of consequence of where you are

Me – do you think we could change that? And how?

PP – yes there are some fiscal arrangements that we could use – which affect the market which are there in other countries and there are some planning issues that we could use and there are some more innovative things that we could do here – things like community plots and self-build plot kind of things and arrangements where we accept we are not necessarily just going to stack one house on top of each other because as soon as you start building apartments you have got to have a lot more commonality of approach than if you have individual buildings – in densely populated places in some areas of Japan you have – you still manage to have individual plots with – and people procure their own houses and they build those and they kit them all out and then 15 years later they recycle them and start again and that's the way they do it – I am not saying that is the right way – but there are other approaches that we could use

Me – we do seem a bit insular perhaps in our approach?

PP – It is quite interesting – sometimes you come across people who are just working for small builders and they have an amazing vision in a particular area and yet they maybe don't have experience in some other areas and they are not sort of joined up – I have a builder building our house at the moment – a great guy in so many ways and yet he will only work from paper drawings and send him anything and he has to go and print it and staples on A1 or 0 before he can use it – so we go along with our laptop and spin it round and show it to him from different angles but he wouldn't use it himself – so there are a lot of things – but I do think that connection details and the supply chain – I have talked about components and supplies and supply chains – I think that that is quite important – it is all about systems integration really – things working together – so there is a lot of that that we don't have established really well here and you find it very difficult to introduce a new product unless it entirely interfaces with all the other products around which already exist which sort of constrain it to be not particularly innovative in the first place whereas actually you want a complete system – but how that relates to Passivhaus, I am not really sure – that is a general perspective

Me – in all the overall statements – you say that you are not a great expert but do you think they cover a large range of issues that you might consider for instance with your own house?

PP – yeah – I think one big issue that isn't covered very well in this set of things is and it is not something I could comment on and it is an area that I am quite relieved that you were not asking me – is about how useable Passivhauses are – and how I have a sense that when they work well they probably give you a very good indoor environment and you feel comfortable and looked after and it is all light and airy and everything is fantastic but if you put three times as many people in the house or something else happens, I have no idea how the house would behave – how it would respond to that – how it would accommodate that and how sensitive the house is to the variations in occupancy pattern and occupancy behaviour and how robust the overall environment and how tolerant it is of those things – so I think that that is an issue and that is then again about perceived control and actual control and Passivhaus, I take it to be Passive? Whereas my understanding is that Passivhauses are not actually Passive, they have active systems in them – whereas my personal approach would be far more to create a house that has a Passive performance – that only needs minor tweaking in order to bring it back into the comfortable range – whatever that is – so start by building a house that is kind of a lose fit in that respect and expect it to wonder around a bit and then you pin it down and then you sort of celebrate the slightly varying environment inside the house rather than having it completely isolated from the outdoor – so I think that that is the one thing about Passivhaus, whilst you might feel really nice and comfortable, but also you might feel isolated from what is going on in the world

PP – I have built several innovative houses and I am doing one at the moment in fact –

Me – what made you go down that route – were you always interested in pushing the boat out

PP – yes I come from a product design and technology innovation is my background – so I did my research on barriers to innovation in volume house building –

Me – I heard that you had that background – that must have been fascinating where did you do that?

PP – I did it at Cambridge in the inter-disciplinary design in the built environment and I built one of the future world houses in Milton Keynes in 1994 – which we lived in for 14 years

Me – you were happy with it

PP – yes it was very interesting – we loved it and we studied it quite a lot –

Me – I am wondering if some of the same barriers that came up in your barriers to innovation might still be coming up?

PP – I then did a lot on off-site manufactured housing – so I think there are a lot of those kinds of things and one of the things going beyond what we talked about today – is that design that encourages the right sort of behaviour – when it is design and you don't actually have to

I have tried this and I can't do the PHPP

Me – it is like one of these new software's you have got to use it – you know loads more than some people who claim to know more in that you have actually tried PHPP

PP - I had an issue only a few weeks ago with my own built house – and the cladding fixing system – which when you worked it out it actually negated all the insulation via tiny little rails only 2mm thick

Me – like having the wall ties

PP – yeah – and the architect said that's all right

Me – it's metal and it conducts?

PP – the thermal conductivity of that is about 2000 times that of the wall so you need – you might as well not have bothered with the insulation at all – and stuck the cladding straight on with wood – we have been sorting it out since – it is those kinds of issues that come up – you get to the end and you actually find a fixing system that will work and you need it on 400 centres and each fixing is £12 – so you are talking £8000 for fixing – as much as the cladding system

Me – you think that the architect really hadn't got a grip on thermal bridging?

PP – he didn't understand – he talked about thermal bridging but he had had no idea and he understood about detail but he didn't understand about material properties

Me – that is very interesting

PP – so you get those things and it is only when you get the whole thing together that you get – I don' t know how much I know until virtually everybody I have talked to having done the whole thing through – several times now with all the metal details –

13.QQ – Policy Advisor

QQ – we have different work groups actually looking at the tool itself – looking at impact on climate change and how you actually want to measure – which carbon metric – all that kind of stuff – and there has also been actual performance versus intended performance – so the actual report is coming out next week and it will have a huge raft of recommendations to government saying basically look – this research needs to be started immediately – now there is if they want to get zero Carbon buildings they need to really sort it out – so there are various things about switching to an absolute carbon metric rather than – things like that and different methods for calculating the different factors from fuels – and actually giving people a forward look at the point of building regs consultation – because there are going to be winners and losers in terms of the technologies – so people need to have some kind of knowledge of what they are going to have to do – it has been a hugely interesting project but you just wonder how much work people will actually be able to do, especially when there is no money to

QQ – it is not restrictive, people just have to change their behaviour from what they are currently doing so – they have to change – I do not know if that is restrictive necessarily

Me – can I now quickly ask you – you have put that one at the negative end as in the construction skills – would you like to say anything further about that

QQ – Because I think buildings are constructed really poorly at the moment and that is not really trying hard for air-tightness and components and proper thermal bridging and all that kind of stuff – so I think there is a huge amount of work that is required in terms of up-skilling the industry and it doesn't just apply to Passivhaus – it applies to more energy efficient planning –

Me – how do you think that would be achieved?

QQ – it is a very difficult question, part of the work that Malcolm Bell has been doing is basically suggesting that having within the compliance tool – that basically you get knocked down if you don't have proper processes in place – so basically having adjustment factors across the whole design process – in terms of design in terms of construction – systems and components working together and in terms of doing some post-construction testing – so that if you can demonstrate that you have got the process in place – you can ensure that all those things work well together – then it helps you in terms of compliance – it should actually mean that industry does start changing in a way that is a timely fashion because it is dragging its feet at the moment –

Me – what about in terms of our design teams and skills – how are we there?

QQ – I think a lot more collaboration is needed and probably a lot more good practice information is needed but not just good practice but bad practice because that is the side that nobody actually wants to publicise and actually you learn much more from knowing the stuff that went wrong to

Me – A bit like the IKEA philosophy – we love mistakes?

At this end in terms of the positive stuff – you have put the UK has a lack of ambition when it comes to building low energy buildings –

QQ – The major house builders – well at the moment they are just trying to survive and even before the financial crisis they have been just happy to plod along and just build to basic regulations not seeing any kind of drive from the occupants of buildings to have low energy design – not in a large way anyway – I would probably say that is not entirely true but that is what they say and that is not necessarily changing anything – they have got their standard house types and with new building regs they want to change those standard house types as little as possible

Me – it seems strange when you compare it with certain other industries – I know all other industries end up going through ups and downs – do you think there are some better ones like some of the kind of high tech industries?

QQ – yes they seem to be constantly trying to drive for innovation whilst – yes there are small pockets of the industry who are driving that way but the majority are not – I mean that is a barrier to a lot of these things really

Me – I am wondering why they are not interested in change – no incentive?

QQ – I can't think that they even, they are moaning about all the new regulations that are coming and the push for better building I suppose

Me – I am just thinking if there is anything else around the middle area

QQ – some of these if it wasn't symmetrical would be put more in the negative really – some of these like the one about high embodied energy – well you are having to use more of certain materials for example insulation and stuff but they are not – but it just depends on what product and it is not specific necessarily to Passivhaus designs so – that is why it is kind of difficult to know where to put some of these things – and this the Code for Sustainable Homes is better than Passivhaus – well they are two very different things so I can't really make a judgement on that

QQ – in terms of SAP versus PHPP – as part of the Hub work for the last task group, we have basically done some comparative models between SAP and PHPP on a range of different dwelling types and starting at Part L 2006 and looking at increasing fabric standards and comparing what the outputs are in terms of space heating and until you get to extreme Passivhaus with U value of less than 0.1 – they actually compare really really well. As long as you have got – what we have tried to do is replicate all the assumptions in SAP – and a lot of people say actually SAP is rubbish and it actually shows that it probably wasn't until you get really extreme designs which you may not want to model anyway – anyway it is interesting

Me – one thing that I am interested in with SAP and PHPP is when you put the windows in and the overshadowing?

QQ – oh yes that is one thing that SAP can't do – the whole over shading thing – so when we looked at it in terms of how it flagged up overheating and cooling - SAP isn't fit for purpose and even its treatment of mechanical ventilation and thermal mass is a bit suspect – that is interesting because I thought PHPP took into account thermal mass much more than it actually does

Me – yes it is quite sort of basic

QQ – yes –

Me – I guess that is something they might also want to do in terms of future iterations of PHPP – but PHPP is younger than SAP

QQ – it seems to have a better programme of feedback than SAP –

Me – has that stuff been published yet that PHPP comparison?

QQ – no – it is about to next week hopefully

Me – did you look at the AECB comparisons? They did some

QQ – I didn't personally but I think others did – I have briefly read it before – there was definitely discussion about it – with all the statements about in the UK we understand or we don't understand something well – we are talking about in terms of as a whole because obviously there are pockets of people who would – so this is sort of as the general kind of industry

Me – yes of course there are brilliant experts

QQ – yeah – what does it mean UK construction skills are appropriate to build Passivhaus design – does that mean the current skills of the people

Me – yes

14.RR – Policy Advisor

RR – you know we are going to form the Passivhaus Trust

Me – yes I have been talking to SS – I know that there has been lots of politics and I was trying to stay out of that – she said you were going to be leading it?

RR - I am the acting Chief Exec

RR – we had a session on ventilation and moisture last week and – it is quite interesting because some of the people came in to the meeting and their view was if we are going to have to get to Code 4 we are going to have to use MVHR anyway – so there won't be a problem with moisture – a complete lack of understanding about the difficulties of making sure that they work operationally – because you expect that people know how to operate them – and expecting low income tenants for example, who have got many other worries to work out and to care about changing filters and making sure that the system is working properly – even if they know how it works and they are taught properly

Me – it is kind of a big ask?

RR – lots of the stories from housing associations – it is not so much about the maintenance bit, but about people sabotaging their systems – so if they feel a draft and is making them feel uncomfortable they plug it up or they put a box around it and then somebody comes along and – there are examples where they have taken the grill off the vent and put something behind or cling-film so that you can't see it and it just won't work – or taking the fuse out of the fan because it is noisy

Me – how is One Brighton – how are the co-heating tests going?

RR – all the co-heating tests are going well there are some areas where it is -100% out on build and all the ones we did the GHA ones are 10-20% out

That is really annoying – the UK construction industry has a fast-buck mentality – if it was the UK house building industry, I would go with it but I am not sure if the construction industry has

Me – yes you tend to deal with the good side of it often

RR – It is interesting about the name – the Germans are very keen that we use the word Passive House but – so a Passive House school? – A Passivhaus school is fine – a Passive House school just doesn't work does it?

Me – do you have much contact with them

RR – yeah

RR – there is about 100 companies that have said they want to join (Passivhaus Trust) – the UK has a lack of ambition when it comes to building low energy building – UK government policy has a lack of ambition well it isn't true since they have set zero carbon as a target – MVHR uses more energy that it saves well have you seen any statistics on that?

Me – do you know of any reports on that?

RR – no we are just starting to look into it now – it seems to be that the operation is the key thing and the theory they are great but in practice?

This guy who came in last week and said if we are going to Code 4 then we are going to have to use MVHR anyway

Me – that is an interesting statement in itself because if you go back to last year when we were doing the CLG reports well that just wasn't what was coming out of it was it?

RR – no not at all – in theory that will be the case but in practice that may not be like that at all – and we talked about Passiv-vent being an alternative – it struck me that you can only go to a certain point with energy efficiency with passive ventilation because you can't control the amount of heat loss

Me – there are even more variables to consider than if you are doing it with MVHR?

RR – but actually if you were to look at 100 passively ventilated and 100 mechanically ventilated you would find that because of the complexities of the mechanically ventilation system – the reality is that they operate at 50% of what you might expect – then you might be better off going for the natural vent that in theory doesn't achieve much but in actual conditions does deliver that every time

Me – I kind of think it depends on the situation

RR – I can't believe that we don't know the answer to that question – I mean Passive-vent have been around for 5-10 years and have been talked about as being the solution for a while and then moved away because of the change in legislation, but how do we not know that? – It's crazy

Me – I guess there is a serious lack of consistency in information – I mean it is nothing new – we haven't just suddenly discovered that we need to ventilate buildings

RR – I am wondering if BRE is part of the problem – we are all saying that lack of BRE is the problem but I am wondering if having BRE as a government funded body in the first place was the problem?

Me – I guess if something is given an official label and they come up with rubbish then you are really screwed

RR – well they are just not asking the right questions – if the house builders themselves were having to do the research to develop problems – whereas if the government is doing research they are probably going to do it from a different angle and are maybe not going to ask the question is it better to have Passive-vent that works at 60% or mechanical ventilation that actually delivers that

Me – yes that sort of approach has worked for the auto industry but at the same time it needed some kind of standardisation of the way that you do things to make sure things turn out safe

RR – the ideal would be if they all collectively pooled into shared research and shared knowledge – which they are not going to do because of commercial advantage – I guess that might be how the BRE got started in the first place

15.SS – Policy Advisor

SS – some of them I don't like the way the questions are phrased – because Passivhaus is well understood in the UK depends who you are talking to – things like that so – something like MVHR uses more energy that it saves – that is an incorrect statement –

Me – you probably really disagree with it then – but there are some people who might agree with that

SS – I know – I have written research reports to stop XX going around saying that

Me – in your travels you say that some people have really good understanding and some people have

SS – I just came from that 10 – 10 meeting and they said a guy from Google had just bought the building next door to theirs in Camden Town – and he is going to renovate it to the Passivhaus standard – and they just say that like everybody would know what the Passivhaus standard is which is quite astonishing

Me – but this is Camden

SS – being neutral with some of these things is actually quite a good thing to be –

Well there is a guy trying to build to Passivhaus standard in our village – and the housing association has got a development and the chief executive who are pro trying to do Passivhaus – but the guy who has to deliver it the project manager – all he wants to know about is the U values – he cannot think about actually it is the notion that it is how much energy that this building is going to use – therefore the U values can vary – so I told him I could take him down to see the ones in Cardiff – he wanted to know what are the U values – and I said you don't want to know the U values cos actually they are really low there because there is such bad weather and the climate is

You see the UK has a lack of ambition when it comes to building low energy buildings – well yes they do because they talk about Carbon - can I put there are financial incentives in there cos there should be if people work it out properly but they just don't -

Educators

16.EE – Architect/Higher Education Lecturer in Passivhaus Design

EE – how did I first hear about Passivhaus – this is probably not what you want to hear but – basically when I started on the course in 2008 – I was running an environmental architecture module and I had a big problem trying to teach environmental software because you have the usual problem of IES and it is too complex for architecture students blah blah, plus you need people who can actually teach it – then you have got Ecotecht which is manageable but then there was problems in getting support – and I tried Ecotecht for one year and the IT method which was a complete nightmare but they are not really the right tools and then what happened is that Ecotecht got taken over by Autodesk and in that period we literally couldn't buy any more student licences – they could only update the licences if a student already had a licence – so I started looking at other softwares and I then came across Passivhaus Planning Package software – and I got from BRE a copy and I started looking into it and as I ended up using it I thought this is bloody smart and I liked the rigorousness – you have obviously got the Passivhaus principles when you – and I actually came into it from the software angle – of course I had heard about Passivhaus but because it wasn't a UK standard it never occurred to me that we should try this in the UK – and it is only through the Passivhaus planning package that I realised that you can use the software for anything – it doesn't have to be a Passivhaus – as a refurbishment building you get the energy demand – I like the transparence of using it although when you first come across it – you are like oh bloody hell – but actually it is more user friendly than ecotecht and more transparent and students are able to understand the underlying factors to it – and this is where I really got into Passivhaus and the course that I am into now and practice as the main standard – this is almost a blessing in disguise and I have found that we have had much less problems with modelling – with Ecotecht you could almost fake that you know your shit – whereas you don't – whereas with Passivhaus you can't do that – this is the thing cos you can never discover because people have to assume that the input was right whereas with Passivhaus – if something is quite unusual well I say can you send me your model and you can go through the model together and you can immediately pick out what they haven't done – the guidance is so fantastic but also you have to understand the principles of what they are doing – they have to understand air-tightness, they have to understand U values – they have to understand over heating issues and there is very, very clear guidance – and that is how I got into it and I was still in practice at that time – and I ended up testing it in architecture on environmental strategies – and particularly in Camden because Camden was really running with this – we were calling up and they were saying if you do Passivhaus standard or close to it we will not be a strict on the renewable because we know that you are putting your money elsewhere – because we understand that renewables is not necessarily appropriate on high

density buildings and that is how we came into it that way – but since then, since the last 18 months I have not really been in practice any more –

One is the first hurdle is that people don't generally know about it – I think particularly now in academia and if you don't have graduates that go out and use it – I mean I know environmental engineers who will come into it with their environmental expertise and all very complex modelling that architects don't necessarily understand – when what I actually like about Passivhaus it is logical it is rational – architects can work with it and understand it and it can be tested and it can be verified and you don't need to rely on engineers so much – so I think that environmental engineers don't benefit to work with Passivhaus – so as a bit of a cynic, I think it is actually quite unknown still – the other thing that doesn't play is that we as – I mean I am not British but what I have noticed in British culture – if it is European, we don't like to do it – we like to do it our own thing – that is why we came up with the zero-carbon thing – and no-one else does – well there is this thing we are doing our own thing and they will do something else so I think there is a slight sort of resistance to European stuff – and that is literally what I have noticed in practice and even in that people will ask me that because it is done in Germany – even from students – I don't know whether you should write that down? – it is unknown in practice but it is changing and that is obviously what the Passivhaus conference is about – so teaching there is not that many courses that teach it – I would also put down a resistance, I think, from engineers – because that is their livelihood – and final thing and this is what I have heard both in academia and whenever we have discussions and a lot of people say that we Brits – we can't have a building where you can't open windows – it is the whole idea that you can't open windows in a Passivhaus and I do think there is some truth – I am married to an Italian and I am Belgian – if I look back when there is a day like today – in Belgium we tend to have roller shutters or shutters because of security but also privacy and it is just culturally, what you have even in Belgium people tend to on the whole have that, and when it is really warm people will just on the sunny side, lower their blinds or roller shutters and you can still get some light through – and it stays nice and cool and when it gets hot outside, people close their windows and close everything down then only open the north side where it is cooler and just for the hottest part of the day for 3-4 hours we will close everything – and we will be outside and then at night we open everything up and get a good breeze – in the UK no matter how hot it is people want a breeze – they will open the windows even though they are sitting there thinking inside is 20 degrees outside is 27 – you know – at one point it is going to stabilise and at one point it is in and it ain't going to go back out – so I do think there is a culture thing about opening windows so I think there is a genuine concern about the window opening, I don't think there is just moaning about it – people can't quite understand the concept that this is just in winter and you can still open your windows it is just that your Passivhaus and your heating system might not work – but there is this whole thing about windows and cost and people just think – they don't want to live in air-tight boxes they are used to Victorian houses which are very very draughty and they complain about it – I think

there is a psychological switch that they haven't made yet and they hear about Passivhaus and hear you can't open a window and they say I don't like that I want to – and that is I think – I was validating a course in Derby and it is a new MSc in I think it is called sustainable architecture and healthy buildings – it is a bit of an old-fashioned name – and I was having a discussion with one of the programme team and one of the guys goes – oh but we don't really want to go down to Passivhaus buildings – what he was saying is that they had no element of Post Occupancy Evaluation and I said look – if you are going to be looking at healthy buildings you need to be looking at Post Occupancy Evaluation – particularly with the move to air-tight buildings and Passivhaus standard – you want to know what the perception is and how they actually operate and what they were doing and he was saying but we don't want to go to Passivhaus because apparently you can't open your windows in a Passivhaus and that is even from the people who are working on these things – and in a way that is possibly the more important one – so window opening and costs, not necessarily in that order – so users is an issue

I have worked on projects going to Passivhaus principles a retrofit and a new build - and I have used the software but they weren't quite pushing it to the Passivhaus standard –

The one saying MVHR uses more energy than it saves – obviously it depends on which MVHR – and how well you have designed everything

High embodies energy ha ha – some of my students are looking at that out of their own interest –

Again this is from my experience – the planning system supports Passivhaus well – I happen to have worked with a quite progressive council so my – I think that that is true so far, I think that they have realised that

The German name Passivhaus is appropriate for the UK market – I agree with that but because of the comments from what I have heard, maybe it doesn't do it more favours maybe we need to take more ownership – clients are ready to adopt the Passivhaus standard – I think they are-ish

Passivhaus buildings are restrictive for occupants – well I have put that where I don't really know because I don't think they are but a lot of people do and I don't think we have got enough buildings that we have tested – in Germany I think it has been proven that it isn't but I think we have a cultural issue –

Passivhaus is appropriate for the UK climate – London or Cornwall is very different to and my world is London but then there is Wales and Scotland and I am going to put it lower because of my world

Effectively what I have done is the things that I recognise as being stifling I have really prioritised that we really need strong representation – and the house builders I have put these with the

highest things that I agree with – cos the other stuff I think we can resolve through building more and more

17.FF –Higher Education Lecturer/Architect

FF – Passivhaus design works well with UK building design aesthetics – well there is not a huge difference between Passivhaus look and a crappy – it can be – you get some beautiful Passivhaus buildings - German name Passivhaus is appropriate for the UK market – yes it is because we like Volkswagen don't we, Mercedes, Audi – it's not the name – Passivhaus standard is very flexible – it depends if it means if the design of the building is flexible or if the standard is flexible – the standard is not flexible at all is it – UK clients are ready to – sort of maybe they are maybe not – some are, Passivhaus designs are future proof – well that does depend – the government only looks to the BRE to develop building standards – I don't know – I have the feeling it is very true – UK design skills are appropriate to design Passivhaus buildings – UK planning doesn't favour it– Passivhaus components are affordable – yes – UK procurement methods – not really – financial incentives to build Passivhaus designs in the UK – ha ha – that could – no they don't understand building fabric performance well – which was my top one – SAP yes that is the key everything else, bad, bad, bad but that – why don't we chuck it out

Me – would you like to say anything else about why you have chosen SAP at that end and our fast-buck mentality at the other end

FF – I think because SAP has been ingrained in our energy approach to buildings for so long and it is rubbish and it is based on a whole series of misconceptions and people don't understand the scoring system, the actual underlying information behind it – SAP is very flawed, you can't apply it to all situations on one hand there is not enough flexibility in it – on the other hand there is not enough rigour in it either – so it can't be used as a flexible tool and it isn't rigorous in the way that with its inflexibility – so the UK construction industry has a fast-buck mentality – and I have put this at the top because the thing that has driven the UK construction industry is, be it house building, be it commercial development, has been very short term – and this is a long culture to turn around but it is going to have to happen now because of shortage of resources, cost of labour, cost of building – those old approaches to design and build and the construction industry won't work in that kind of climate anyway – so that has been a major problem – so anything that has investment or long term thinking on the part of the developer or what required a client to think long term as well has – in the last 10 years it has been about how much money can I spend to make twice as much money when I sell it – although that is not really a Passivhaus approach although you could say it was more attractive for occupants to buy but because we are also very uneducated about Passivhaus that doesn't have any hold in the market so – I mean all these things can be driven by lots of different drivers at the same time – there is not one thing to turn it around but they have all got to happen – and the fact that we have got a fast-buck mentality you can't directly target that thing, you have to target lots of other things to change that and some of it will be legislation driven and some of it will

be what happens automatically as a result of the economic climate thing – people are going to have to think longer term –

As I said, I think that there are some things on there that I am not sure about because of my own ignorance but of course I am representative of the UK as much as anybody else – I have my own limits about knowledge about Passivhaus – so for example whether MVHR improves indoor air-quality or not I would say in a rough sense it depends – I don't really know – again I don' t really know if the German name Passivhaus is appropriate for the UK market or not – I don't know what other people think about it – I would have the feeling that it is ok and that people are getting used to it – I think it would be a disaster to change it now because just as people are beginning to get used to it as a term – to start calling it something else – no that is a really bad branding, it is going to take a long time, it is really pointless – I definitely disagree with we understand building energy performance well and this is the heart of the problem isn't it – the supply chain, I think that can be a problem if you are talking about the MVHR system or other aspects – there is one on here which isn't on here which I would have thought would have been perhaps, thinking about it – which is about the idea of not having a heating system – or a conventional heating system – and I think for a lot of people that is like kicking away their crutch – and expecting them to get up and walk – they think they need it – it is an automatic part of any house – most people in the UK haven't lived without a heating system for decades – of course essentially there is a heating system but it is just so different from what people are used to – the other stuff I agree strongly with is that it is going to take the house builders to adopt Passivhaus – I think that is true because again that is not something that is going to happen overnight, but the fact that they take it up will be a sign that lots and lots of other things have happened – in fact maybe it is the other way around – if the house builders take it up that will have shown that it has caught on – they are the people who have to take it up, it doesn't matter about anybody else, in a sense they are not going to be the early adopters but by the time they have taken it on then that is it – that will be the sign won't it – Passivhaus needs strong and coherent representation in the UK – yes – definitely I couldn't agree more – and something and straight forward like having a case study and examples here is so important so it is great what people are doing – and the stuff about training and education, I think I would have put more up in the agree bracket if there had been more about that, but what did we have about training and that sort of thing – it is about this representation which is the nearest one on there – I disagree that we have the skills, there is a statement about skills – yeah UK construction skills are appropriate to build Passivhaus designs – well they are not – we just don't have the quality control on site – we don't have builders who are used to careful detailing – so we definitely need change in skills training –

The reason I like these cards is because the comments on them have been condensed already and they seem to be the right kind of spread – I am not thinking where is that card on – which could be my own limitation – and I also like them because of the way this is structured – it gives

you a lot of general stuff in the middle but it forces you to think about your priorities – at either end of the extremes because that is how we think isn't it – and then it is all facing me which makes me feel very important

18.GG –Higher Education Lecturer/Physicist

GG – I have no idea whether they offer good comfort having never having talked to anybody

Me – that is ok

Me – what is your job title

GG – professor, I think or Senior Research officer

Me – are you an architect

GG – no I am a physicist

Me – where did you first hear about Passivhaus

GG – oh lots of places, I have been in low energy buildings a long time, so whenever it first got talked about I suppose

GG – you can see why I am worried when thinking about the building standard as it requires a very high standard – just look out of the window

I have recently been to Bradford to low energy buildings and there are problems with over-heating – two years running in one of the schools children have fainted in exams

I think the problem is firstly that corners were cut – on one of the buildings they said that the architect was banned from the site a month before it was finished which tells you they were cutting corners all over the place – things like automatically opening windows that were supposed to open when it go too hot and they hadn't put in the opening part

Me – because they thought that looks expensive so we will chop that off?

GG – In a cupboard somewhere they found a whole load of the things that were supposed to open the windows and they had obviously never can't afford to do this with time – we have run out of time – and then you have got a corridor that over-heats because you have got a big window – it would be difficult to fault the design without looking at it quite closely because probably it is partly the builders because bits were done – you get a subby to put in the ventilation system – there is one where there were three offices next to each other like this – this one had ventilation and these two didn't but the partition between them had obviously been the last thing to be put up – and probably the subby had come in and said, we don't need them all the way down, we will just put them up here – so when they put in the partitions these one didn't have them – the classic one is these big open offices where some of the managers decide that they need their own office – the managers offices are built around the edge and all the people who are meant to be doing the work are stuck in a stuffy middle thing with no ventilation – the other thing is that the standards for

ventilation are about keeping people alive – and CO2 levels and all that sort of thing and you can do that quite easily with a little fan – but as soon as they are using it to extract the heat in the summer – it is just not enough – you are going to have to be able to open a window – and some of the offices did have windows but it was like this you would have to climb on to a table to get to the window – you can imagine the teacher I think – and there was another thing – they had put in CO2 alarms – no instruction about what you were supposed to do when the CO2 alarm went off – so it kept going off – and the kids of course had found that when they breathed on the alarm it would go off – so all that the teachers could do was to trip it – so there was absolutely no point in it at all – so it makes you feel that anything too reliant on good building standards will require a revolution in the British building industry

And another thing – I saw in Scotland where they have had to import it all from Austria – and in Scotland you are right in the middle of pine forests – there is plenty of wood around but they just didn't trust the local builders to be able to build it to the air-tight standards that were required by Passivhaus – I don't know whether it was Passivhaus but – I would like to go back and see how the thing is actually working out – the climate in Scotland is very different – if it was designed for Austria – it might all be warping or swelling or –

Me – this is why we are chatting – people come up with lots of issues but these seem to be key core issues

Me – are you Dr?

GG – No I am just plain BSc – In those days not many people did PhDs – I just went and worked at the BRE where I was trained on the job, which you don't get nowadays

Me – yes people are rather left to sink or swim but clearly experience is the key thing

GG – yes – what are Passivhaus components

Me – things like the special windows or MVHR – potentially some membrane materials, things like that

GG – has it changed your attitude to Passivhaus because in Edinburgh you seemed to be?

Me – I gave a presentation just saying what it is

GG – yes she attacked you in a completely unfair way – she has a bee in her bonnet

GG – How does it apply to refurbishment projects?

Me – there are loads of refurbishment projects – there are lots and lots on mainland Europe – and there are people working at the moment on a scheme called refurb for the future –

GG – it says that the UK has a lack of ambition – well the UK government has a lack of ambition but I don't know what that tells us about the rest of - are they expensive?

Me – certainly to start with they tend to work out being – but there have been examples where they come in at being cost neutral – in fact our first Passivhaus building in the UK came in at no more expensive than its equivalent type of building – depending on the construction methods that people use

GG - It says that MVHR uses more energy than it saves – I don't find that – there are other things that I would have problems with it – like it would break down or get blocked up – high embodied energy I think of as bricks and concrete –

Me – it depends what you make them out of

GG – we understand building fabric performance well in the UK – that is another one of these vague – I agree that we understand it but it depends on who you are – when you come to a school of architecture like this one where they really don't take environment seriously at all

Me – do you know of anybody who is working on any Passivhaus projects at this Uni

GG – no I don't think so – there is a research group –they are mainly doing stuff on schools but I don't think low energy has much of a look in – I also work at Oxford Brooke so I know people like xxx

The only way to make low energy buildings work is to have a team of people check the filters and see that things are running – the other slight worry is that it is not climate appropriate here in the way that it is in central Europe – they have colder winters and hotter summers

I did mark a PhD for somebody from Denmark and they said the big problem for low energy design there was that people have been told because of dust mites etc. that people should throw their windows open several times a day – and they did – well trained Danes – and of course all the heat that goes shooting out it doesn't matter how much heat exchange you have got in your heat exchanger –

Contractors

19.JJ – Passivhaus Contractor

JJ – so we did have a situation where there was a lot more collaborative working going on and we did try to follow the Egan agenda – but the problems come down to cost in first of all people don't know or understand how much a building should cost – surveyors can't tell you whether that is a fair value for a building – therefore it is a problem if you are negotiating something so if you have got a fairly static price level surveyors can look at a previous job and say we tendered that one and it cost so much for that job therefore it is a reasonable price to – when you have got prices falling like that and people bidding below cost it is very difficult to go into a negotiated situation and negotiate a price that

You will have contractors with a senior management who will sit and look at the paperwork and actually identify the holes and identify where the claims are going to come from before the first day of the project – that sounds a dreadful way to do it and it is in a sense but from their point of view, if they don't do that they are not going to get the work – if you are actually going to choose it purely on the basis of what is the lowest price then you will get a fairly inadequate set of documents – the example is if you had wrote out your specification for a car and you had all these holes in your specification and then chose the cheapest price you would have a lot of problems with it – it is exactly the same with construction – it doesn't really work –

Me – but clearly something else is happening with a car? People are expecting a certain level of performance and people don't actually go along and provide a specification – you go along and expect to buy a working finished product – the same with a computer or mobile phone clearly things go wrong but

JJ – the question is – how do you move construction on to that kind of basis when you have got kind of one-off projects? – and one of the things to me that is totally lacking in construction is in a sense reputation – you might buy your car on the basis that it is an Audi or a BMW or whatever or what particular mark you like – whereas in construction there is an assumption in this world that all contractors are basically the same so you are not – you might choose your tender list for example with some nod to quality – but one of the things I always wanted to do is to in the RSL market to get all the development managers to get together in a pub and actually talk about all the contractors they deal with – because I remember a situation when one development manager tearing his hair out because a particular contractor has been so abysmal so that they say we will never use them again and then you see that another housing association down the road has just made them their preferred contractor – and they are just publishing record results and there is nothing that tends to feed back – maybe there is an expectation of poor performance that – nobody seems to feed back and say well they did a good job, we will use them again

Me – it just seems to me very weird when you have buildings where you are spending a large proportion of your day and your life – and energy use and resources use full stop that why do people treat such a major thing with so much disdain

JJ – it is just overall a very strange process that we go through to kind of procure our buildings and design and procure our buildings – we are pricing a job – in theory it is all done for cost purposes – we are currently pricing a job that is social housing and it is a phenomenally expensive design

Me – does that come from the original set of plans that you have no influence over –

JJ – no not the way things are – we are not getting involved at an early stage so we have no influence over it – now the housing association will go to the greatest possible lengths to choose the cheapest price for building a very expensive design and be happy with that but they didn't need to have as an expensive design as that is difficult to build – clearly it has been designed without any consideration as to buildability – clearly there has been no structural engineer involved to see quite how the structure is going to work and that whole kind of process of not being kind of joined up really doesn't help if you are trying to do a Passivhaus particularly at the early stages of trying to establish Passivhaus in the UK – cos you really do need that team-working approach – you do need to look at it like you don't have the experience of doing it, you don't have the skills – so you really need to work with what skills we have got and work with builders and work with all the design team – to iron out those areas of problems – those issues – so that we can have a UK version of Passivhaus – and if we do our Passivhaus designs again with an architect in isolation – without involving anybody else, again you are going to have the same problems – you will have very expensive buildings that probably won't achieve what you want to achieve

Me – you have got a lot of awards?

JJ – yes but not so many lately because we haven't gone in for so many – we do tend to find that a lot of the awards go to the larger companies – the worst one of those we went for a Sustain-construction sustainability award and we used an FSC chain of custody materials on a lot of our jobs in fact one of the Ann Thorne jobs where we had done 95% of the materials as FSC products and we didn't get the award, we got short-listed – and the guys from constructing excellence, the same award the guys the next year actually asked me to present it – so I ended up having to present it to a large contractor who had done an office fit-out using FSC products and this basically meant he had used FSC doors – and I was presenting it to him and thinking was it worth the award we went in for with a whole building using FSC when he has done one because he has used some FSC doors and I thought well come on – it kind of says it all really

Me – who won the award when you were short-listed?

JJ – I can't actually remember, it was us and four of the largest contractors in the UK – Bouygues and Mace and so on so I wasn't optimistic – we get a lot of interest because we actually employ a lot of our guys which is the other side

Me – that is an interesting area of discussion full stop

JJ – I think it is key to this – the average way of recruiting people to work on a project is to choose them at random from an agency or from a sub-contractor – you are not actually going to get the best if you are going to do that –

We are doing some work with Loughborough at the moment and trying to improve the lean construction processes – which tends to be ignored because of the fragmentation of the industry – doing it more efficiently doesn't really matter because you are going out to tender as cheaply as possible –

What do you mean by people?

Me – what do you think?

JJ – I don't think the public have an opinion about that, if they did I think they would think that they would think that renewable energy is the solution because that is the way that it is pushed

But if you are talking about the industry or clients who are involved in building then I think it is a fairly accurate statement

Me – why do you think that is?

JJ – I very much think there is a strong element that it is pushed right the way down from the Government, through client and through planning and that has been the way that we have looked at it – and we are pushed in that direction through local authorities and planning and the people in the planning departments don't understand the importance of fabric

Me – clearly there has been some attempt in Part L for people to improve fabric

JJ – I think it is changing and we are finding some of our clients who are kind of interested in terms of fabric and less interested in terms of adding on a bit of eco-bling to the building – but if you are still looking at a planning condition that says you must add on a bit of technology for 20% or whatever of a carbon reduction then you are going to have to do that – ok you can reduce the total amount of energy usage in a building so ok your ten or twenty percent becomes less, but that is pretty marginal in a sense if you are looking at the kind of cost elements in a sense – it is much cheaper to do a poorer fabric and put on the renewable technology – cost is obviously a major issue

Me – cost has to be a major issue

How many people work for you?

JJ – about 50

Me – that is quite a lot

JJ – this again is a problem that we have – our turnover is relatively low in construction terms but in terms of number of employees, we have as many employees as firms 5 times our size because they sub-contract everything, but when you go to get on framework agreements or get larger jobs everyone looks at the turnover – so they have got 30 million turnover, they are a bigger firm than you when actually they have got 20 employees because they sub-contract everything and all they have got is a few surveyors and some finance people

Me – do you employ skills from across the board?

JJ – we have carpenters, we have bricklayers, plumbers and decorators on the firm we have site managers who stay with us and one of the key things is the continuity so we have people who have done some projects and worked on our schemes before – and then moving on to construction what tends to happen is you have some really good projects that work really well but then that whole team can be broken up afterwards – so there is no kind of internal learning – same kind of thing in the construction side of things – the people who are working on construction on some really successful projects can say that went really well but it is not a firm that has adopted it, it is a project team of sub-contractors and the sub-contractors may disappear off and not get used the next time, even the site manager and agency staff members will all disappear off somewhere else – there isn't the coherence – we have improved our air-tightness and one of the ways that we have done that is that when we are actually doing the air-testing our guys watch – we get our carpenters to watch it and they have actually made changes based on site simply based on what they have picked up from seeing stuff, so they understand why you are doing it but if you didn't have the continuity of staff you wouldn't get that, you'd just have people there for a couple of months and then disappear off

Me – would you say that is typical? Do you think in a team people would be bothered to show people things

JJ – No I don't think they would and to be honest if we were sensible I don't think we would either

Me – why wouldn't that be sensible?

JJ – essentially the way we operate and the way we do it makes us a more expensive builder and that's why we have got this whole in-construction process going on at the moment to look at the process to try and make ourselves more efficient because we are inherently more expensive and we achieve better results in air-tightness but I don't really think our clients are that bothered about

it – if you took a sensible approach you wouldn't do it, you wouldn't build to those levels because you should build what your client wants really – in a sense it is almost a conceit if you like – it is quite good for the moral of our people in terms of what they are doing but the quality level is appreciated but it is not appreciated in cost terms – people won't pay more effectively for us to do the job – particularly at the moment very much so – everything is tendered, everything is at its lowest cost so our alternatives are to change the way we operate and not do it like that or use the advantages of having that kind of direct labour to become that much more efficient – so we do it quicker than everyone else so we can maintain kind of quality levels

Me – so overall there may well be an incentive to do things badly?

JJ – in a sense there is no incentive to do it better – and logically in a sense that is right, if you are building something or providing a service to somebody then you should provide a service that they want and are prepared to pay for – there isn't really a point in providing a service that is over and above what they are prepared to pay for – arguably that is waste in a sense –

Me - so if you were talking about waste and doing an efficient business then you probably wouldn't try – you would try to cut corners would that be the – but isn't that just passing the waste down the line? So what might happen if you have a less air-tight building, you are putting more energy in to it in terms of heating or cooling it and all the rest – and therefore the waste gets passed on to purchaser or operator of the building – or whoever is paying those bills – do you think that the people who are in that situation are aware of that?

JJ – No – but some are to be fair – but what I was saying in terms of waste is that if you are building a car, then you build a car to what your customers want – if your customers want a certain type of engine then that is what you build – if you build a more super-efficient engine and it makes the car too expensive for people to buy it then that is kind of a waste and is not good business sense – you are quite right that by doing that you are building in extra costs for the residents when they move in and I do think that some of the clients – we work for RSLs we do social housing and some of the people with in the client groups do appreciate that and some don't – and they are under great cost control and cost considerations and their considerations are capital – rather than revenue cost considerations so they have to get the stuff at the lowest possible price so that is particularly true at the moment when tender prices have dropped by typically 25-30% - so they are under great stress to achieve that so they are not going to give as much consideration when it comes to the quality of the building, the air-tightness and so on – and the lower energy costs that are attributable to our residents –

Me – some people think that if you did have people who were skilled enough on a regular basis then there would not be any cost premium associated with that anyway –

JJ – I disagree – if you look at – if you actually looked at how much it costs Barratts to build an average house, we couldn't get anywhere near it – you are talking probably 40% cheaper than we build it - there is a big difference between cost of buildings in the private sector and the public sector – public sector housing is much more expensive in terms of build costs – if you look at the buildings you might say there are good reasons for that – but they build a lot cheaper – I don't believe it is correct to say that if you have highly skilled people doing the job properly that they will do it as cheaply as somebody who is cutting corners – that is a nice idea and it would be lovely if that were the case, but I don't accept that

Me – why are you doing things to such a high standard if you think that everybody else isn't?

JJ – it is probably not fair to say that everybody else isn't – but I think a lot are not – I think that any business has to have a culture, has to have a way of working if you like and that principally is our way of working – we have decided that we are going to go down that route – having direct employees, going down the route of trying to produce a quality product – we would find it very hard to change that approach – so in a sense what we are trying to do is to gain advantages through that so we can try and do the job as cheaply as somebody that is not doing as high quality work by using the advantages we have got – so we use the direct labour because we have got the direct labour and we can learn – from one job to another and we can learn in terms of process efficiency – in a way that if you are bringing together people in an ad-hoc basis for each project you can't – we build on our strengths and we are still trying to convince clients that it is worth spending a bit extra to get that extra quality product – so in a sense I suppose we might be a bit stubborn

Me – your business model seems to me to be more similar to processes that might go on in places like Germany or Austria – where you may not seem to have as many of the large firms operating in the ways that you describe and that those countries have (whether that is the reason) seem to have produced more Passivhaus buildings and potentially more better performing other buildings -

JJ - certainly the way that construction is structured – there are large parts of it that work more on that sort of basis particularly outside of London – you tend to get smaller regional builders that work on – and a lot of them have their own employees and work to a very high standard, I am not trying to suggest that we only do that it is just that we – in our market place it is dominated by the large project managers – which is effectively what they are they are not actually builders so I think that that kind of dominates the market and they are in the kind of position to pick up a lot of work so I don't know really how Germany and Austria is structured in that sense – but certainly I think it is very difficult to get the general standard of quality that – the general skills within the workforce to a high enough level in the way that we are structured now – so you will get firms that can build to Passivhaus standard absolutely, you will get the large contractors that can build to Passivhaus standards – you won't get the general skill within the construction industry up if you have a situation where it is based on casual labour and sub-contracting, sub-contracting, sub-contracting –

if it is based on lowest price at all time at all levels then you don't get the general skills up – I don't believe that there is anything inherent that says that the building construction industry can't build to the same standard as the Germans and the Austrians – and they don't want to – in a sense one of the advantages that we get from the way we work is that our guys are very committed to what we do, everybody just wants to do the best job that they can – I think that is a fundamental , if we start from that basis and I think that somebody like a carpenter or a bricklayer want to show off and use their skills – so the air-tightness that we do is something that really interests the guys for some of the guys and girls that are out there working, it gives them some kind of satisfaction

Me – so they are actually proud of their job?

JJ – yeah absolutely – it is sad unfortunately in a sense that a lot of the time our clients aren't terribly interested –

Me - how do you think you could make clients interested if that was desirable?

JJ – I think a bit of understanding – I think there is a real kind of education process that needs to go through – I don't think the clients understand the relevance of air-tightness and the relevance of improving the fabric of the building – clearly local authorities don't, planning departments don't, they haven't got a clue – so I think there is a big education bit to actually understand that this is something desirable and why it is desirable – then it is a question of once they understand it to kind of adopt it and say this is the way we are going as a client and we are going to accept that maybe at the early stages it is going to cost a bit more to do it – ok you are quite right that the cost differential might reduce – I don't think it will disappear – but I think the cost differential will reduce as you build more and more buildings that

Me – but maybe things are artificially cheap because of processes? If there is such a thing as artificially cheap

JJ – if you are talking about volume house builders then they probably are – things don't seem cheap and a lot of that goes into the land but certainly the construction process is artificially cheap because of the kind of processes – and there is a very big, and again I don't know how Germany and Austria work, but we have a relatively small number of volume house builders – and they have a lot of clout and you will find that legislation will come up and it will get altered and one of the things that we got involved with fairly early on before the air-tightness was sound testing and there is obviously a great connection between the two anyway and when kind of sound testing came in the original idea was that your building would have to be tested or a percentage would have to be tested but very soon robust details started to come in deemed to satisfy started to come in and that was the house builders lobbying, they were terrified of the idea of actually having their buildings tested – I know in theory the robust details are tested on a kind of random basis but there are differences in what you have to achieve – you have to achieve a minimum or an average, there

are a lot of differences in that – there is a massive world of difference between looking at a design that is going to achieve air-testing results and an actual building that does – and that way you see the kind of house builders lobby affecting the kind of legislation that goes through without really kind of testing you are not going to get anywhere

Me – I am going to ask you about what you have done – first of all at either extremes you have put our planning system...

JJ – I have put the planning system supports it well as being the most negative one because that is what we talked about before – things like the Merton Rule – I met one of the guys that was very heavily involved in that for absolutely the right reasons but it really doesn't square very well with the Passivhaus standard – at all and that kind of emphasis on adding renewable, a lot of which are a complete waste of time or have a very very low real impact and effect so that ended up after much consideration in the lowest position –

I actually had more difficulty at the other end finding something that I actually agreed with that much – and I did change that a couple of times – I think that again it is very much associated with the way that the whole process has gone through planning and also through media and government and so on – it goes back to people like B+Q selling Chinese built wind turbines to stick on urban buildings – I went to Ecobuild about two years ago and one of the seminars that I went to was on small scale wind – and there were speakers there and to be fair each speaker stood up and said it doesn't work in an urban setting – it is a waste of time – then there were questions like which particular wind turbine should I use in this setting should I use this one, is this one better than the other one and the answer would be – it doesn't work – then somebody else would stand up and say but which one should I use – it was like nobody actually wanted to hear that it actually doesn't work, they just wanted to have a wind-turbine stuck on their buildings – we are green, we have got a wind-turbine –

Me – clearly some of the other micro-renewables are more effective – but there is a degree to which they probably can perform

JJ – and we use primarily solar thermal as the main technology that we use and I think we are one of the major installers –

Me – and you work with guys who work with you to install the

JJ – our own plumber installs the stuff – he has just come back from Dusseldorf actually – where he has been doing a bit of training

Me – it is interesting that he goes there for training and not somewhere in the UK

JJ – yes well they don't have (we are kind of using the one product) the kind of facilities to train over here at all – there is just not enough people doing it to make it worth while

We are doing a job for a housing association at the moment where they have got air-to-air heat pumps and I nearly lost the job as I sat in the interview and said I think it is a waste of time doing this – and we have had to put in PV now because the air-to- air is not qualified as part of achieving their renewable bit – a vast amount of money they spent an enormous amount of money and they had these aesthetically dreadful things stuck on the roof – and that is it they were told it was a good technology and it was the mechanical engineers that said this is a good idea to do

Me – you seem to have been quite lucky in working with quite aware architects but maybe you have come across different architects who have different ideas or a different stance

JJ – Ann Thorne's are very rare in terms of their actual knowledge of the subject and interest in the subject and it is a fascinating thing to actually talk about the code and how their approach actually starts from a building that tries to understand the principles of what they are trying to achieve and that is very different from trying to meet the planning or get the code or whatever – but their level of knowledge is vastly higher than the average architects – the average architect's knowledge of green building is pathetically low –

Me – maybe the engineers too?

JJ – engineers as well – M+E consultants are a nightmare anyway for any builder – it is a major issue for us and most of them are very poor – again some have some interest in the subject but others go off at great tangents – and getting the co-ordination of looking at the kind of fabric side of things rather than looking at the technology side of things is again very difficult with M+E consultants – and we have ended up doing a lot of the stuff really in house that we – it is quite useful we have our own SAP assessor now – we had somebody trained up as a SAP assessor – we can do code stuff in house as well – we had a student over from Austria who was looking at thermal bridging - which is quite a big area that I can say that I don't understand but there are virtually no architects who are working with thermal bridging details or understanding them or working with M+E consultants who understand it – I know Ann Thorne's are and they worked very closely with Simon when he was on his little project – it is almost kind of sad that we were doing that as the contractor –

Me – maybe everybody needs to kind of do it to an extent –?

You have put these two as your second most agree with which is that Passivhaus buildings have to perform as specified to work and Passivhaus needs strong and coherent representation in the UK –

JJ – from my point of view it all comes back to this idea of testing and you can have a set of design standards that purport to achieve something but unless you make sure the building does actually achieve those designs and is built to the correct quality then it comes down to testing – I guess my concerns with a Passivhaus are that if it ever got watered down so you had a Passivhaus version of robust details then you didn't actually go back to check that first of all when the building is built that it is properly built to the standards and then for monitoring afterwards to see if it really is – which is really very very limited at the moment – with any of the buildings where you are putting in technology you are talking in terms of heat recovery and mechanical ventilation – you are also talking what people are putting into buildings and the way that they understand how to use the buildings is as important as the design and the construction – again we are finding that if it comes down to the technology element then we are putting all this kit in – even the solar thermal and we end up with these complicated controls and basically people move in and they don't understand how to turn it on and off – and we have had an example on one we didn't build where they had a whole house ventilation system where the inlet was actually above the bed and people searched out how to turn the whole thing off so they had a moderately air-tight building so it is very important to make sure that you go from design to construction and from construction to use –

Me – and the key bits here in what actually does it mean to be neutral? – you have got here Passivhaus designs work well with UK building design aesthetics – you have got Code for sustainable homes is a better standard than Passivhaus, you have got PHPP is developed well for UK design scenarios, UK design skills are appropriate to design Passivhaus buildings, we understand building fabric performance well in the UK and the UK government only looks to the BRE to develop building standards and the Passivhaus standard is well understood in the UK

JJ – some of these I was struggling to get to neutral with – I don't think Passivhaus standard is well understood in the UK – I don't think the UK government does really just look toward the BRE but maybe they look to the BRE a bit too much so – we understand building fabric performance well in the UK well some people do, some people don't so that struggled into the – UK design skills are appropriate well we talked about the design skills and the lack of knowledge and certainly there are the potential there – there are the people like the Ann Thorne architects there are the people who do – PHPP is developed well for UK design scenarios well I suppose I don't really have the knowledge to say yes or no – code for sustainable homes is a better standard than Passivhaus – that got to neutral really because they are different – in terms of energy I think Passivhaus is vastly superior to the code for sustainable homes but obviously the code for sustainable homes does cover more other items – Passivhaus works well with UK design aesthetics – I left that one to the architects, I am a simple builder –

Me – would you like to say anything else about this stuff in general? What do you think about the selection of these statements?

JJ - the selection of statements are fine – I think that most of them were fairly clear – I had to shift stuff from minus 5 across and across all the time and

Me – you would have had a giant minus 5 pile?

JJ – I would have had a large minus 5 pile – again a lack of knowledge and understanding and direction – I think there are some signs that the direction is moving more towards a Passivhaus type approach or at least a fabric lead kind of approach – it is starting to come but it has got a long way to go – and as a result of that, things like skills and products and supply chain they don't exist in the UK – we are trying to do this retro-fit for the future and windows are coming from Poland and other stuff is coming from Germany and etc. etc. – there is not much of it that is actually coming from the UK – simply because we haven't really built up the critical mass

Me – how can that change?

JJ – it has to be by building up a critical mass and that can really only change through the legislation side of things – a change to concentration on the fabric, a change to concentration on the testing and making the renewable side less important – not getting rid of it by any means but making it a lesser point than it is at the moment – and I think that that has to come through the legislation - we are tiny players in the construction industry in terms of new building – if you look at the private side then it is the house builders and they only respond to what they are told to do basically that is the way it has to work it has to come through the regulations – through building standards and so on

Me – and what about in terms of financing that? –

JJ – in terms of financing that that is a big issue – because obviously in the next few years there is not going to be public money going in to this and the social housing sector is the most advanced in terms of construction – if you are going to move the social housing sector as a start on to more of a Passivhaus approach, it will cost money and I am not sure that money is going to go through – they are going to be cut significantly in terms of their budgets they are going to be expected to get more and more units out of what they get and I suspect the government is going to try and get the likes of Barratts and Wimpeys to build more and more of the social housing – and that is going to be an interesting process cos when they have tried to do that before, the standards and the requirements have put them off – they kind of ran away a bit and in the second round they have kind of made it a bit easier for them and they have come back in again – so the other thing if you are not going to provide the finance for it then you are going to have to do it through the legislation – which I don't necessarily think there will be the will for either because there is going to be a problem with the volume of building of housing in total in the next few years so I don' see an awful lot of progress actually

Me – that is very interesting if there is a move to get more private sector into more public sector then and you say the larger firms theoretically produce a cheaper product then if you get them involved in social housing then you say they have a massive influence in terms of lobbying and they don't like the standards at the moment or are frightened by them it may be possible that they would want to try and change those standards?

JJ – yes I think that is right – they will want to water them down and that has been consistently the way that it has gone in the past – they have watered them down that is a very strong risk that that watering down process might be acceptable to the current government possibly

20.KK – Passivhaus Contractor

KK – what would you consider by uptake – minor or major?

Me – either – whichever you think is most relevant

KK – lack of knowledge of standard – skills and lack of UK designs/ building systems – cost is probably one but lower down – no legislative drivers or even legislative barriers

KK – have you worked on any Passivhaus projects in the past – NBT has

What does this mean?

Me – it refers to it being a German language product and much of the literature available being in German

KK – but German products are seen as good products

Me – yes they are but if they can't read the instructions...

KK – you had quite a few questions that I have put over here about procurement, skills, communication between design team and I suppose procurement covers the whole thing to some extent – for me the big problem is the whole supply from – the linkup between all the different elements – I suppose that is one thing – the uptake of Passivhaus in the UK – I think there are some general things which I think are kind of mentioned but they are to do with bigger economic things like land values – the relationship between the value of the land and the value of the building you are putting on it – if you are paying a lot for the land anyway, you can't afford to pay much on the house – Passivhauses are going to be more expensive to build – you can't build them for £50,000

Me – you can't really build a house for that – it depends whether you want to call it a house or not

KK – yes absolutely but that is what you are competing against in terms of land values – there are also various kind of general understanding issues – people don't really understand about energy in the UK – energy literacy and carbon literacy as well – if you said to lots of people it would save you five tonnes of carbon a year – they have no concept so why would they even want to think about it

Unfortunately there are very structural thoughts in the industry and the country in terms of building – in terms of building performance and one thing is we don't have a trusted public body – so that I think is a problem for all new buildings – you know I think that BRE will probably discredit Passivhaus rather than give it credit because they are not trusted – they see it as another way for BRE making money – and the other thing is that the government themselves are incapable of making decisions about energy because they have got rid of all their technical experts – how can you have policy that helps if you have got a knowledge free civil service – so those things are kind

of critical really – so there are some big cultural, structural, sociological things that mean that different building forms and different standards get taken up in different countries and we can't pretend we have the same conditions as other countries – and you can't necessarily think that by fixing some of these things that everything is going to open up because some of these things are very big and long term – so the Passivhaus Trust can do quite a lot to address some of these issues and you can put in training schemes and various other things but you are not going to address the land price – and you are not necessarily going to address the legislative thing – possibly can through the Passivhaus Trust – and I think it depends on how far it wants to go in terms of what it does – although I am a Director of the Passsivhaus Trust I don't necessarily think it is the right thing – I tend to agree with Poran Desai that legislation is for the lowest standard not for excellence – it is quite dangerous to legislate for excellence – most of the people that I know who want to have Passivhaus as the minimum standard for zero carbon homes are insulation suppliers – so you have to see Passivhaus in a wider context is I think what I am saying – also I think that there are real - I mean I, used to be very put off it because I thought it seemed to be a cult – I am less put off it now because I feel more comfortable with the way that the Passivhaus Trust has developed and the people that I know who are involved in that – I mean things like MVHR which are kind of a key element to it – I had a word with Adrian Leaman and he said that in Holland there are real problems with MVHR and a lot of them have been taken out of buildings – so to have a solution that you say is the solution and you can't brook any decent is not helpful – at the moment if you do Passivhaus you can have a very low energy building in my opinion which doesn't have to have MVHR, there are other technologies that we need to keep ourselves open to those – and that is one of the things I would have found in the past restrictive of its uptake – cos I don't think people like being boxed in to a particular standard – if it is seen as a methodology as one of many standards then I think we are much more willing in the UK to take it up – because a lot of the stuff is really good and I think it provides an excellent beacon to shine light on other poor standards – and it is definitely better as an energy standard not as a – you have got here the code for sustainable homes – but it is only trying to do one element – unlike the code for sustainable homes – the code for sustainable homes is a complete mess in virtually every area and the energy is particularly poor – so I would certainly say that it is better than that – the code covers water, it covers construction waste it covers lots of things so it is not a comparable standard – that's where I am with the uptake of it, I suppose the other

Passivhaus/Sustainability Consultants

21.A – Passivhaus Consultant

Me – how did you get involved with C

A – Through my previous post and through Passivhaus – emails and he asked me if I wanted to come in for an interview

Me – are you noticing a greater uptake of Passivhaus

A – yes there is a growing movement of enthusiasts – and I think that that is a good thing because people are going to have to take notice – we are getting about 100 – 150 enquiries a month – some of these are very basic but some big construction companies are actually interested in building –

Me – how many accredited schemes are there

A – Probably about 10 now

A – I am a non-German speaker and the Passivhaus we are working on at the moment – the client is Dutch and he is a German speaker and he is using German contractors who are building Passivhauses and all the information that I require to certify the building is coming through in German

Me – but there is so much literature that is available in German – huge amounts in German and loads of research stuff

A – I have even suggested that BRE offer basic language skills

I guess one thing I would add, it mentions that there needs to be better communication between the certifying bodies that are kind of governing the standard in the UK and are also leasing with PHI – there are some issues at the minute that we are trying to resolve – I think PHI – they are only a small company but they need to kind of develop their thinking if they want to go global – they are quite happy for people to take it globally for them but they

22.D – Passivhaus Consultant and Architect

D – The data base will continue to be an issue – one thing is we are looking at measured energy and they are looking at primary energy and they don't really – they didn't do it and they don't think it is necessary and I was trying to say that

Me – so their database is all from the assessments rather than from the measured data afterwards

D – Yes exactly – but there is air-tightness that is one measurement that they are taking – but in terms of gross energy use for electricity or gas – so that is an extra – it is an issue

Me – do they think that is something they would like to include in the future

D – no they are pretty – they have established a kind of self-check system –

Me – so they kind of believe that if people say it is, it is

D – Exactly – well it is almost as if it hadn't even occurred to them well it had because there was the CEPHEUS project – that might be it because they have seen that

Me – so they thought that the 229 was a significant quantity

D – possibly – I don't know because I have only spoken to individuals about it – it has always been a kind of individual response the official PHI response might be different – because they have developed everything so far down one route there is no way in hell that they are going to back up and split it now – and also as you put information in their database there is a certain checking element saying this can't be right – these figures seem slightly out or something is not quite right here – whereas ours is I suppose we could do that but it is kind of built on trust

Me – so it needs to be refined you would say?

D – Yeah well refined and what we are thinking about now is a link between the two so say if – to avoid having people go into the retro-fit AECB project and having to do the same for Europe –

Me – because that is the area where there should probably be most concern about the retro-fit performance

D – yes because air-tightness is quite important and even small changes in that have quite big impacts – I don't know if this is something that they have looked and say – if they match the air-tightness and haven't completely messed something else up then – I guess that Matthias who is the German/EU database manager said well in 5/10 years down the line this will be the standard and we will all be doing it so what will be the point – again quite optimistic – but I think we need to know at this stage what we are achieving

Me – I think it is interesting in terms of the variety of different construction types you are going to get throughout Europe and understanding the implications of that sort of thing

D – There is a concern not only with weather data but with internal temperatures of either 20 or 21 degrees – people drop that and stick with getting things built now

Me – how is it going with the weather data for the UK?

D – At the moment it is still as it was because I think £350 to BRE and you get what you are after

Me – so basically you still need to do 17 or 18 regions – well you have got one

D – They will need to be split up using the regions from SAP

Me – why have you put the code for sustainable homes at the far end of most disagree with? And why have you put Passivhaus needs strong and coherent representation at the other end?

D – The code, given that that has been the horse that everybody has been riding to zero carbon – and maybe it can be seen as more holistic – in a relatively short period of time it has become a standard in the whole of the construction industry that everybody understands and – but one of the problems at risk is that that is perceived as – why should we go for something else when that is it doesn't look at rain-water or it doesn't look at this or that – the misunderstanding and the lack of awareness in terms of what are the most valuable things to look at – impacts and scale – and what is going to have the biggest impact

Me – do you think there is going to be a lack of understanding of perhaps the energy issues?

D – yes – and the importance of energy in use as opposed to embodied energy or a lot of the ecology kind of credits kind of thing – I mean an ecologist probably looks at that and thinks that seems absolutely ridiculous – it is a numbers thing it is not a kind of qualitative it is a quantitative – but I guess this is quantitative as well but as Pete quite rightly pointed out the numbers have a meaning and reason behind them whereas this doesn't look good so we will stick with that or something

Me – before there were 4 accrediting associations do you think that now there is going to be?

D – Well that is what I hope and I think this – well one of the core concepts is that people need to know what Passivhaus means and

Me – even in these presentations tonight there has been a different representation of the name –

D – on the CEPH course if you get certified it is Passive House – in English which – that issue is one that is related to – I think the skills anywhere can accommodate the standard it is the willingness and the attitude –

Me - would you like to say more about that end of the scale?

D – well this is just being clear that if it is Passivhaus or House – two words English spelling – if they are talking about certification and the process involved and what that actually means – well people think it has got this much insulation and triple glazed windows and it may have a U value of 0.15 – just because it ticks those boxes on paper it doesn't mean that it is a Passivhaus – because it doesn't mean it is a Passivhaus just because it doesn't have a heating system and there will be confusion with this too

Me – you think that is still an issue renewable?

D – it is often the first place that clients look when they say we want to have a green building – solar panels and – ok solar panels are one thing but they might want PVs or wind turbine – it has been portrayed or put out as – it is visual it is something to see – but without understanding the physic well not even the physics – well actually people could save a lot more energy doing something else – you might save much more on insulation

Me – at this end you have

D – well it is encouraging to see a lot of the larger housing developments testing it – the major house builders well in Britain that seems to be – there seems to be pockets of things that are happening –

Me – I don't know if you would like to say anything about what you have put in the centre?

D – well again the embodied energy thing, I think that – actually I went to Disability Essex in mid-June as part of Passnet kind of recording – there was one guy that was just banging on about this and he was saying that there is new research to show that embodied energy is actually a bit more important that we thought it was – whereas I come at it from that it is the energy in use that far out-weighs the energy in the materials until you get down to until you consistently get down to this extreme level then it becomes a bigger chunk of the whole – I would normally try and look for something that is lower embodied energy but there are arguments – you have got limited energy and focus and time and – a lot of these the detail and the communication, skills – I think it can be done in any – anywhere – so I don't see those as an issue I suppose for us – PHPP is developed for UK scenarios well – the problem with PHPP is not that it is focused on the German way of doing things particularly, it is that there is no front end – it is that aspect that is the problem all the terminology everything is the same – there is a hell of a lot of detail that people don't normally see –

Me – the measurement conventions and the weather data?

D – yeah – again kind of starting back from first principles, I think it kind of that does seem to be the one that might actually but there might be more leeway of change – if you are – even then I think there are issues because if you have a good string of years or – I do know it is about the methodology and the heating loads – but in terms of how the weather data is calculated – whether that is appropriate for the UK or not – I am not sure – I think fundamentally if that is the only issue then it is – in a way that is easy enough to solve there is a route out of there – there is nothing like oh we can't have this sheet or that sheet – because it is all physics it is all international – and the same thing with the weather data – it is an additive thing just putting stuff in that isn't there –

Me – what do you think about the overall spread of statements

D – It seems a pretty good coverage – I think that the only thing that seems to keep coming up is the understanding of what it means – and the fact that that fundamentally isn't there –

Me – there is a lot of people here tonight but how many of them have a good understanding?

D – There are those that have built and certify on one level and then there are those that and everybody else who was at the Passivhaus Fest and there are

23.II – CSH and Passivhaus Consultant

Me – how long have you been with the xxx?

II – I joined September 2007 so almost three years now

Me – and you have always worked on BREEAM and Code?

II – I used to work for materials which is the domestic team – so materials, code and BREEAM and I have been appointed to do the more residential sector

Me – quite exciting doing the code – movement in terms of lots of development

II – it is quite challenging at some point but I think it is really good to hear expert's opinions and others as well

Me – T said that you are working on new visions for sectors of the code at the moment

II – yes that is right – it is going to be quite difficult I think because at the moment it is owned by CLG and you don't know what is going on but in a way it is good for them to actually own it because as a Government you have the opportunity to drive the market whereas as a private thing like us

II – is it the Passivhaus programme PHPP?

Me – yes if you don't know about something it will probably end up in the middle

Me – I quite liked doing that on-line chat thing

II – it is very messy I think it was really scary as well because you were in the second one the housing – it was quite scary because my computer suddenly froze in the middle

Me – I had that too and then I had just lost it

II – I am not sure about this one – it says that Code is better than Passivhaus but it is a totally different thing

Me – the statements are generated they are not my opinions as such

II – I think that one comment that hit me the most is the fact that people think that code is much better than Passivhaus because it is two totally different things – interesting about the mechanical ventilation – I am not very aware of the technical side of things unfortunately I don't have really much view on that and I really strongly agree with the fact that at the moment Passivhaus doesn't have a strong representation in the UK and hence the reason that not many people are actually aware of it and they just are more enthusiasts but during the last discussion more people actually

talked about the code, wanting to know more about what it is about and rather than us actually telling them that there is Passivhaus and it can be implemented into Code so

24.S – Sustainability Consultant

Me – you have put at this end that you don't agree that Passivhaus buildings are restrictive for occupants – so you think they are completely flexible for people

S – No but I don't think they are restrictive –

Me – and at this end as your top most agree with – Passivhaus is appropriate for the UK climate –

S – Lots of buildings are specified to be high performance but once they are occupied their performance is completely different – and you can't call that a sustainable building if it is not performing sustainably – it might have intended to be but if it is not – you can't call it a sustainable building in my mind – so part of it is a soft landings kind of approach, education teaching people how the building works and the kind of involvement that the occupants need to have with the building

Me – is that something you get involved with as a consultant? Telling people even clients how buildings work?

S - not so much, we don't often have access to the people who are going to be in the building who are often not the ones working with developers or contractors, some of the developers operate as landlords and then you might have the opportunity to talk to them, but obviously down the food chain you have facilities managers and so on and we don't often have access to them to talk to them about how a building should be operated

Me – do you think there is a great potential or need for facilities managers to have more training in terms of building operation?

S – absolutely, absolutely – you hear stories about – I think there was a school once and apparently one of the caretakers used to spend 2 hours every day going around every classroom turning off the lights – no-one had told him that there was a button on the BMS that would do that for him –

Me – how do you think you can rectify that?

S – in using things like soft-landings more – I think the principle of it is so important to get that message across – to get the occupants input into the design and construction of it – and you teach them how it works and they understand the construction –

Me – it seems to me that not many people know about soft landings?

S – No we are trying to spread the word a bit more – obviously it is fairly new as well

Me– is there anything else here that stands out as particularly unusual?

S – I noticed there were lots of statements on UK designers having the skills and understanding and the construction skills – I put a lot of these in the disagree camp

Me – as in you think they don't have the skills?

S – yeah or they don't have the knowledge – so many times I have seen architects draw something up and the engineers have to somehow make it work – because the architects aren't taking on the responsibility in the first instance of addressing simple things like orientation and fabric and location of windows and spaces within buildings that optimise the Passive nature the way they should be used

Me – why is that? Do they just not care or do they just don't know?

S – probably both – in my mind I think people are adverse to change – and to change the way we have been designing for 10 or 20 years is just too much to contemplate – you hear some people say – I have been designing buildings this way for 20 years I am going to keep on doing it like this for the next 20 years and I have heard developers say that – you know the Canary Wharf crew do – basically they built Canary Wharf 20 years ago and the idea was when they were doing the Wood Wharf thing was that they were just going to put up the same stuff because they got the tenants, they got the rents this that and the other, the model works so why should they change it – why should they in their mind build something that is more expensive – and potentially have a lesser return on it –

Me – but they will potentially be impacted if people are demanding more low energy products and office space

S – yes they will be – they will not change their tune while they see no demand for it because they see it as being very expensive – so I think a lot of the understanding, the communication, the skills going back to basics with design just isn't there – and I wonder if the current economic crisis is just making that worse because obviously there is less money around to deliver the same thing or more – so people are having to cut corners re-gurgitating the same stuff – there is no incentive to spend time learning to make it better –

Me – so instead of using this as an opportunity to re-skill or re-learn –

S – it is not an option, there is just not enough time – I think the government is doing, like the Welsh government has set the target – they have set the time line but lots of builders and developers are just floundering – they don't understand how they are going to achieve those targets – within those time frames – I think it is great that the government is pushing those standards but on the other hand if people don't know how and costs are imperative they are scared about how they are actually going to do it

Me – how do you think that could be improved?

S – What will make it better do you think? Well education is an obvious answer but it is not always the easiest thing to deliver – somebody needs to lead by example, someone needs to sit down and say this is how it is done, here's some stuff that we have already done – put some costs on the table, people don't understand the costs – talking to the planning team yesterday, they have got a client doing a housing project in Wales and they originally put a housing application in five years ago I think and it is due to expire shortly but obviously that planning application went in before the requirement for code level 3 came in and the scheme is atrocious but the developer thinks that delivering code level 3 is going to cost an extra £5000 per house so he wants the planning application amended rather than re-done or re-submitted – because he thinks it is going to cost £5000 per house to do code level 3 – which is wrong it is much cheaper than that you can do it much cheaper – obviously there are minimum mandatory standards which is possibly one of the more costly things – but it doesn't have to cost that much more – a lot of other things in the code aren't going to be that expensive to deliver either – the developer was just pushing the planning team to see if they would amend the application instead of re-submitting purely because he was scared of the code –

Me – you do a lot of code and BREEAM assessments how do you think that that is working as a force to drive change? How effective do you think that is in terms of delivering realistic sustainable and or low energy buildings?

S – I do not think that doing BREEAM or code is a guarantee that you are going to deliver sustainable buildings – particularly where you have a situation where the planning team wants to achieve a BREEAM excellent – I have seen cases where developers have had to throw money at a project putting in facilities or using consultants to do studies that don't necessarily add anything meaningful environmentally or socially to a project – but it ticks a code or a BREEAM box – because they have to get that excellent they have to throw that money at it – you have schools in terrible locations where children would never cycle – you have got developers putting in cycle stands because it is the cheapest way to get a BREEAM point – it is a waste of thousands of pounds that could have been spent on something else for the kids – I don't see it as holistically driving sustainability – I think it has raised awareness around a broader range of issues of sustainability – lots of people think sustainability is about energy – it is not it is about so much more than that – and at least BREEAM and the code are raising awareness of those issues and the importance of materials and water as a resource and dealing with waste – so I think along those lines it has been beneficial, I just don't think I agree with the way it is run – and I think people have to learn how projects work – they see things as very black and white – the construction industry is and everything in design is generally grey – they like to box things that can't be boxed

Me – so how do you feel about the zero carbon targets for 2016 and 2019 in terms of housing and non-domestic? Do you think this is something we are moving fast towards meeting?

S – no I don't think so – I think lots of people are filling gaps by doing things like biomass boilers – they are cheap and if they are not operating the facility then it becomes somebody else's problem to source the fuel – and maintain it and run it

Me – but technically on paper that would contribute to making the scheme zero

S – but we need to be looking at the building itself and reducing the amount of energy that it is using first – and in some ways that is easier and in other ways it is hard if you don't know how – it is very easy to put a bit of capital up front wack in your biomass and get your 20% - they understand that the 20% is going to keep on increasing but they don't understand how – they keep looking at easy fixes so it is going to be a bit of a rude shock when –

Me – so you think there are going to be a lot of buildings that are apparently built to low energy standards but which are not going to be performing in the near future or that need to be refurbished so that they perform better –

S – refurbishment is an interesting question actually – because the legislation is targeting new buildings – not targeting refurbishment but it – not that many people are building new buildings at the moment so – I think the cost benefits of doing refurb are going to become a lot more viable in the future –

Me – do you think we have the skills set to understand how to do refurbishment projects? –

S – I think we are part of the way there perhaps – but there is a long way to go –

Me – how do you think we could better our knowledge about all these things?

S – We need concrete examples so that we can show people – and that is the trouble there aren't many of them – there is a lot of green wash in industry and people are saying that buildings are green and they are not

Me – what do you think about taking people to other countries to show them examples?

S – in one way it is really good because you can see the examples for yourself and learn – but taking people overseas is not necessarily very sustainable – but if that bunch of people could suddenly start delivering much better things in the UK then you could offset the carbon emissions hundreds of times over –

Planners

25.MM – London Planner

MM – In Australia we have a state based planning system so every state has a is own resources and finance and investment but there is sort of a – but at least there is still some structure – on large scale where you have got infrastructure – where your roads need to go, where your airports need to go – water infrastructure all those kinds of things – it's a good advert not to sell off all your infrastructure – when energy was cheap in the old days you could say what do we need that for but now –

Me – you were talking about heat pumps

MM – the government says that they are renewable technology and because they are the easiest ones to put in – but I was always going in Australia they are called reverse cycle air-conditioning units – you get a lot of cooling out of them and then they use even more energy – so I am always having to ask for some kind of carbon calculation for the heat you are getting out of them – the best is a traditional gas boiler in terms of carbon content –

Me – at this end the one you have put that you most agree with is that Passivhaus will only catch on if the major house builders adopt it – why have you put that one there?

MM – because they build most of the bulk in terms of the housing – so in terms of getting the costs down and the components, production line and training up of skills, all the things that kind of deliver a Passivhaus you need volume to get the tail end going as well –

Me – and next door to it you have put the UK has a lack of ambition when it comes to building low energy buildings and also Passivhaus is appropriate for the UK climate –

MM – there doesn't seem much will to rock the boat in terms of building methods or standards, I know the government has got its zero carbon timeline but I am not sure actually what is being done to meet that target – because without changing the whole way you construct buildings or getting the training off the ground then you are not going to meet that target

Me – so what would you say are the best ways to meet that target

MM – you do need a clear timeline which is what we have – I don't know if there is going to be any stick at the end if it doesn't happen – so it is said that it is going to go in the Building Regs so to me that should be clear enough but you need some more monitoring and seeing where we are now – especially in terms of building control who don't seem to do much as far as I am aware – they do air-pressure tests but that seems to be about it – I don't know what else they do really but that is all I really know what they do –

Me – you mentioned something about skills – do you see anything happening in terms of training?

MM – I guess I am on the planning side and we do – we try to train up a lot of the planners but it is still not necessarily their priority – we have got so many other things to think about – affordable housing and does it look ok and negotiating loss of a tree, by the time you get into that level of detail the energy kind of slips way down there somewhere but then it should really be a building regs thing, it is about air-tightness what windows and U values and all that kind of thing – it shouldn't really be a planning issue you shouldn't have to think about it – it should be encompassed in how you design things – training we have approved a training centre at Kings Cross for the wider Kings Cross development but I think the skills are still quite basic – how to put up a wall, how to do windows, how to fix

Me – so would that centre just relate to that development – clearly once people have been trained they can go and work somewhere else but

MM – it was funded by Kings Cross central but they can go anywhere else because Kings Cross is a bit behind schedule there is not exactly anything there to build yet –

Me – and up this end the ones you really disagree with – you have got UK construction skills are appropriate to build Passivhaus designs and you also have we understand how to detail buildings well in the UK and there are financial incentives to build Passivhaus designs in the UK

MM - they are all a bit more detailed that what I normally deal with in day to day planning but I work quite closely with our housing team and they do a lot more detailed stuff and they did the zero carbon house in St.Augustines road – and apparently they had to do all their own detailing about how to get the insulation around the corners and they wanted to help English Heritage do detailing around the fire places and around the windows and the shutter boxes but because the English Heritage did their usual thing and refused to be involved – they didn't worry about detailing –

Me – why did English Heritage refuse to be involved?

MM – they wanted everything retained – because it was original fabric

Me – In the central region you have put things because?

MM – because I don't know – I don't know if mechanical ventilation with heat recovery I don't know if they use more energy than maybe solar thermal – I know it is a different concept and with some of them you get free heat or even ground source heat pumps – I just don't know enough about them in detail – in terms of the BRE thing I am not sure if that is an issue or not – I wasn't really fussed either way – as long as there is a strong organisation that they are listening to because obviously there are people like the UK Green Building Council – I don't know if they do the same

level of detailing that the BRE do – I don't think it is a problem as long as they are getting the correct information –

Me – is there anything else you would like to say about the whole thing and the coverage of the types of statements?

MM – I think some of the agreed ones I did agree with them a lot more strongly than the others I was less indifferent about them –

Me – for instance which ones?

MM – I guess the one about indoor air-quality – that could move up a few and the one appropriate for new and refurbishment projects – that is obviously true so it could go up – it just needs to be highlighted that you can retro-fit the measures – it is only that we are working in a central London borough and it is a prestigious place to live that people are willing to invest that extra for the exact house that they want and they design it from the ground up basically as opposed to bulk housing builders with that is what there is choose it, if you don't like it there are plenty of other buyers just because there is not enough housing to go around – but house builders always say there is no demand for that sort of thing – but there is no choice out there so how can you tell – there is maybe one study – I can't remember who it is where they put solar thermal on some of the houses and they got % return for them

Me – are you working with members of the public and people bringing in their plans? –

MM – I don't actually mention Passivhaus because I don't want to scare them, I always talk about more insulation and better air-tightness because they are the two basic principles – I always try and go down those routes and in terms of insulation I tend to start with the Energy Savings Trust best practice – so it is just pecking away at people slowly – going well obviously if you can't meet your 20% so why don't you improve the insulation and the renewables target will go down – and air-tightness best practice is 3 and the standard we see is 5 – so that is an improvement but

Me – and how do people respond to that? –

MM – at the moment because we have 8 week turn around – it goes into the condition or the 106 detailing – and it just says the general guidance is so you can reduce your renewable target and decrease your energy – and improve your energy efficiency – and therefore you should try and address these issues – and then they are supposed to provide you with another report prior to construction –

Me – is there any post construction thing that goes on to see if they have done it –

MM – everything over a certain size has to do a post-construction review – like a BREEAM one – there is the energy section where you can make sure they are complying with but that is about it –

even if they did send something in for me to monitor, I wouldn't know how good it was really – so at least with BREEAM or the code you have got something set so you know roughly how good it is –

Me – anything else you would like to say about this?

MM – was there one about the code for sustainable homes – I think the only reason I slightly disagreed with it was because the code covers more than just energy – such as water consumption – so it is important that those other elements of sustainability don't get lost – I am not that clear how they calculate the energy credits any more – when it was kg CO2 then I understood but I think it is something else now –

Me – yes because they have just had a new one out

MM – yes – because it is hard to tell people how to improve if you don't know what the measurement is – I just don't have time at the moment to do all that research –

Me – it is a lot of work going through all those things

MM – yes – it is having time and knowledge behind stuff – so you can slowly encourage people – it doesn't help when they keep changing the system or measuring system

Me – because it was only about a year ago the last one

MM – yes – well this government has got rid of EPCs so who knows – hopefully they will get building regs up to scratch – it is the monitoring side – especially that self-certification no-one knows what is being built really – because if you are paying the person who is signing it off it is in their interest to

I think the bit about low carbon buildings and renewables it is getting better in terms of focusing on energy efficiency over renewables but I don't think renewable was ever supposed to cut out the first bit but it just happened that way because there was a specific target that they wanted to have a number that they can link on to – so you can focus on that as opposed to the hard stuff at the front – or it is supposed to be covered by building regulations anyway – I suppose as a planner there is a conflict because building regs are supposed to take care of that – you should be asking more techy people to delve into that more techy world -

26.OO – London Planner

OO – our planning system supports the Passivhaus standard well – it depends where you are applying for planning – and also I only do the energy part of planning, I don't do the if it looks nice – you see I struggle with Passivhaus because we get a lot of people and developers who propose whole house mechanical ventilation with heat recovery and then try and get away with doing air-tightness of 5 which is better than building regs but I don't think whole house mech vent is particularly worthwhile when doing anything unless with air-tightness of less than 3, and they get really narky with me when I suggest that and I am well you know if you are going to do whole house mech vent and airtightness of 5, I had rather you do no mech vent and air-tightness of 7 and they are

Me – what do you think of the new Part L? –

OO – I don't think they are being strong enough with the buck stops with the U values – we sort of get U values of – we ask people to put U values in external walls of below 0.2 – if they put in 0.2 they are only putting in a back-stop of 0.3 so – at least we are going to move away from the houses with the tiny little windows – they are good for a laugh and I like the whole concept of the thermal massing but I think it is going to confuse people –

I had one developer who said to me I can't make an air-tightness of less than 7 because it is not built out of timber it is built out of masonry or something – and I said that is absolute... some people ... and you think you are trying to pull the wool over my eyes – what they come up with it is ridiculous – PHPP is quite overwhelming isn't it –

There is good communication between different members of the design team in the UK – not if you watch Grand Designs there isn't –

Well this one is a bit weird – if the mech vent is in a Passivhaus then it is probably ok but if it is in a shoddily built English house then – have you been to the ones at the BRE? – It's a bit like living in an air tunnel – not the speed of the air but the sound of it

Me – that is really interesting because I have been to see several Passivhaus developments in Europe and they are actually completely quiet

OO – I think the BRE, considering they are supposed to be kind of pioneering these kinds of things –

So I am going to put that one there because I have never actually been in one – I know there are issues with Passivhaus and planning – it is not planning it is building regs –

Me – you have put at the minus 5 end – UK construction types are appropriate to build Passivhaus designs as in you don't agree with that – would you like to elaborate?

OO – I don't think that the construction industry has sufficient training – it is seen as a low skill job at the moment – and unless that attitude changes and the skills are better taught then I don't think that – we can have all the fantastic designs but they won't be built the way that they are meant to be built

Me – what about the other end – Passivhaus needs strong and coherent representation – you agree with that a lot?

OO - yes – because I think that is the only other way you are going to get all this other stuff to work at the moment – there is a little bit of resistance to Passivhaus, there is a little bit of resistance to – there is not enough understanding of it – you hear people say that it is more suited to a particular climate, maybe not to this climate because you need the solar gain – and I think it has been allowed to grow organically but that has not been enough if you actually want it to take off it is too

Me – also at the positive end you have got that you agree that you think it is ok for refurbishment and new build and you say people in the UK are frightened by the high degree of air-tightness associated with Passivhaus design

OO – yes because when you deal with planning the arguments from some people developers when you try and go for higher levels of air-tightness are – is the biggest issue they face is summer overheating – so they think that people will suffocate –

Me – are they aware that other countries have much higher standards in terms of air-tight buildings?

OO – no – I think they struggle with the ones we have got here – but I think there is a lot of mis-information around the air-tightness and Passivhaus that is the big Daily Mail headline isn't it – you know people will suffocate in their homes and it's a bit scary

Me – in your middle zone I don't know if there is anything that you want to talk about what's going on there or

OO – cos obviously at that conference there was a talk about the fact that we have got too much regulation and too many different types of regulations in this country – we have got code and code is really exhaustive and sometimes gives rise to bizarre anomalies – and personally I probably think that adoption of Passivhaus standards would probably be – with some element of code related in terms of sustainable sourcing of materials and some of the site specific things in code like recycling and water use and whatever – if you could probably keep those but if you just used Passivhaus it is probably going to be – if you link up that with the strong representation and people just understand that this is what you have got to do – it has been done in these countries loads – they can do it and we can do it here then – it frustrates me because I see a lot of people – I see an

awful lot of people going for code level 3 and we ask for code level 4 and they say to get code level 3 we have got to put all these renewable on and we have got to get to code level 4 – we just tell them to go back to the actual construction itself and as far as I am aware, Passivhaus is kind of akin to code level 4 but if you don't put renewables on it so it would simplify things – we talk about this a lot – are you talking particularly about Passivhaus for use with houses? Because we are looking at it for commercial as well –

Me – that is a thing that comes out a lot is that people think that it is only for housing rather than for anything as such

OO – cos I think with schools and things like that – we have got a lot of BSF schools that fortunately haven't been cut – they are all still on – although I don't know the energy use in BSF schools usually goes up mysteriously – we have got one called Highbury Grove and we have got to monitor that – but the other thing that I was looking at that we discuss at work is and what they have come across in the Albert Park one is that the workers had to be imported, the actual frames and everything had to be imported and the windows, so the whole house has to be imported at which point you do think well at this stage, how advantageous is it – so at this stage the supply chains are not there to allow people to just go and build them, I don't think the skills are there and this thing with mech vent – it comes back to education and it comes back to the biggest issue that I see is that we – I see a lot of well-designed buildings with good intent – in use it all goes out the window – so you would have to educate the people who lived in these buildings –

Me – how do you think you would do that?

OO – well the concept of Passivhaus is good in the sense that it is not over-complicated – a lot of the buildings that we see – a number of the buildings that we see are so complex – I suppose the advantage of Passivhaus is that it is supposed to be reasonably simple – I think you would take them into – like what's his name Bill Dunster, he takes people into the Rural Zed or whatever it is and he lets people basically hang out there and realise that it is comfortable and you haven't got a noise in the background and – I have got a minor issue with mech vent at the moment when they are built in standard houses cos they – I don't like the concept of putting all that kit in if it is on a standard built house – I can understand how it would work in Passivhaus and I think it might earn its keep in Passivhaus but

Me – there is one other thing relating to code and you said that code sometimes brings up these weird anomalies – have you got any examples of these?

OO – it depends on if they are trying to achieve certain credits – the code seems to inform the design so much and I know that with the water credits it can cause issues – the other issue as well is with the renewable energy because they have to meet a 44% total reduction in regulated – they will use a whole host of renewable technology – there is still a resistance in this country to improve

the actual building – they would still rather build slightly shoddy buildings and put a load of kit on it really – a favourite at the moment is air-source heat pumps – cos it ticks boxes – so if you had Passivhaus it would be that one standard – and that is it and how you get to that is – so I think that that would be more interesting

Generally we see a lot of reliance on technology – and renewable technology – to achieve code – but with Passivhaus I think you would get away from that – because it is the building itself that has to achieve the 15kWh – also SAP that is the other thing that comes up because with code it is reliant on SAP – we have a number of buildings that have put forward, and that is where the air-source heat-pumps come in – put forward electrically heated buildings because it gives them advantages within SAP methodology – vast advantages in SAP methodology – so you can get away with building a slightly worse building if you heat it electrically – you can build a worse building and heat it electrically than you can a gas building –

Me – so you theoretically could have quite a high level code building that has electric heating because it might not have very high air-tightness parameters but then has loads and loads of renewables on the roof – what you get is because SAP and SBEM favour because they do the DER and the TER – so SAP does TER and DER – your target emission rate is based off how a building would be if it was just heated electrically – without any air-source so – your target is higher because your notional building is electrically heated – so you have got more scope so you can actually build it – so it is a complete disaster really that you can actually get away with building a building that is worse

Me - do you think people realise that in the industry?

OO – well when I worked in commercial before I got a job here – one of the anomalies that came up SBEM not Code was – we were involved in doing the Part L compliance checks on pretty much a warehouse and it wasn't passing Part L – but it turned out it could get to pass Part L if they put air-conditioning on it – so it didn't require air-conditioning it was just a warehouse – when they put air-conditioning on it, it passed Part L – its nuts so I think there is more than enough awareness out there about that – this whole design for the future is purely concerned with the mech vent and some reasonably high level of tech kit has to be run 24 hours – and if we are generally moving to a state of Armageddon – we have houses that have got a bit of kit in them that is require to keep the air-quality there – that is my only concern – that they work incredibly well right now whilst we have still got reasonable access to things that can fix it and repair it and stuff – I am just concerned that 50-60 years down the track are we going to be able to maintain them? That would be my only concern, but hell you can always open the windows – but either way they are still built heaps better – I am sure you can retrofit a wood burning stove – and punch a few holes in the walls – and also people get a little bit twitchy about not having any heating in their buildings as well – marketability

that is what we hear – all the time in planning – we must build a tall skyscraper that looks like a fish bowl and fill it with air-conditioning because that is what they want –

Me – but how do they know that that is what they want?

OO – I know – you know what – people don't want to change – they want what they know – we get really narky at them but it doesn't really work –

Me – do you find there are conflicts of interest between what you are trying to do and the aesthetic thing –

OO – definitely – we tried to push them to put brise soleil on a building recently and they had already got into problems with that because that apparently didn't fit into the aesthetic of the local area according to a planner – and our planning department is usually very good so I can't imagine what another planning department is like – so we do face the odd bit of opposition from them – on the whole they are pretty good but we have got issues cos two thirds of Islington is heritage – so we are trying to get solid wall insulation in and we tried to agree a solution where we can solidly insulate the back and internally insulate the front but apparently that if you can see the back and it's a beautiful building –

27.NN – London Planner

Me – you have got at this end that the planning system actually supports the Passivhaus system well and you really disagree with that

NN – well I think that the planning system is probably the first thing that needs to support any changes in measures

Me – at this end you have got like the fast buck mentality

NN – not that I have got major experience of the UK construction industry but I think it is majorly profit driven – things which do cost more at the starting point are always going to create problems in getting people to adopt it and I definitely see the very short term profit focus as a very hard thing to change, especially when the benefits from it are always from the occupation side – the developer had never really had an interest in that apart from housing associations

Me – how do you think you could change that?

NN – well I think housing associations are a good way to start and I think and we do need to build more affordable housing in recent years – and the housing associations have become more burgeoning arms of the construction industry towards residential at least – and hopefully their demands will start pushing industry in that direction because people think of anything such as high levels of the code as how much does it cost and I think that is one of the key things that has to be changed to get people thinking in a different direction

Me – what do you think about the idea of offering people incentives

NN – I think that that is a good idea – obviously how to pay for them is a more difficult question – I think that is one thing that you will be able to say to the HCA that if you are going to build to this standard then – obviously they have funded the code for sustainable homes then they could broaden their remit in terms of adopting other ideas – from the way I see it anyway it is more to do with the money –

Me – what about the things you put in the middle – do you want to say anything about those –

NN – One particular thing is this discussion about the Passivhaus in the UK climate – I have only briefly looked at PHPP and I am not an expert – I don't really design and develop to Passivhaus standard but I have heard various discussions between people saying Passivhaus doesn't suit the UK type climate and it is very good for continental type buildings but I am not totally sure on the outcome of that and whether it has been tweaked properly to adapt to our needs that is one area in my mind that I am not totally certain about another one is the use of Passivhaus for refurbishment projects – I have not really thought about that before so I am not really sure whether it is or whether it isn't – If I found out a bit more I might be able to make a better decision on that

Me – there are loads of refurbishment projects in Europe and there are a few that are in progress here – they do make some allowance for you to have a slightly higher kWh per metre squared

NN – I think that has got a lot of applicability for the UK because I think the retrofit thing is really starting to take off in terms of Government talk anyway – whether that results in too much – there are a few projects around London where they have done quite adventurous retrofits such as the Camden house and Russell Smith the Parity Projects and things and if Passivhaus could have been included in some of these projects it would have maybe been a good idea

Me – anything else you would like to say about anything there?

NN – well that Passivhaus components are affordable in the UK, I don't know too much about all the costing and all the different bits cos I kind of think that it may be the case that some things are expensive in the UK compared for instance in Germany or Austria – but some of them probably aren't and there is bit of a lack of understanding completely about it – for instance the idea of MVHR is seen as an expense and then if people start to think about getting completely rid of the wet heating system then it is not actually much more expensive – but it is just not in the standard mind-set – the way things are packaged up – UK construction skills – obviously I am not a contractor so I am not completely on the ground with construction skills but I think that more the issue about being able to do it is the detailing it is more to do with the quality than the skill – and attention to detail, maybe the way things happen is that people tend to do the least cost and the quickest so that is probably where it tends to lose out but I don't thing necessarily that the construction skills are at fault it is more what is driving them – obviously there is the use of SAP, I don't think that SAP is – SAP isn't a design tool whereas PHPP is more of a sort of design tool and SAP has been tagged along as a fuel poverty method for indicating how much it would cost at any time using a method that we must adhere to which I think is wrong – we should move off from SAP or use a different version completely – I think that that might help – but this is an interesting thing the way we need the major house builders to at least start to talk about Passivhaus and do some projects which could immediately get in the forefront of people's minds as to how – to ask about it and say why don't I want a Passivhaus and that would help especially the way housing is delivered in this country – and there are major house builders who do deliver quite a large amount of our housing – if they are talking about it then they will soon get other people to follow –

There is quite a lot of talk of MVHR in these and I have disagreed with this one in that is uses more energy than it saves – and if it is used properly then it shouldn't be using more energy but there are obviously cases where it has been installed and you can't deny that if it is not done properly there is that potential – similarly with the air-quality issue, there are examples of where if it is not done right it can cause a deterioration in air-quality – but actually doing it right in the first place is key – you can hear stories where people have put in these systems and residents have blocked it up or something – it is really I think we don't tend to think properly about how we use buildings and if that

is the case for people who work in the building industry then it is going to be even worse when you put people in there, especially when you have been used to typical UK buildings where you open the window, if it is cold you just want some fresh air – I think it is going to be harder to get people educated which I think is which is big difference in mind-sets between the UK and Germany I think

Me – did you think that when you were there –

NN – yes there is definitely a different way that they approach recycling and they have about 15 bins and you musn't put the wrong thing in the wrong bin and people will tell you off and I think the environmental thing has been much more in their minds for a long while and obviously you can see the success of their green party and politics for a long time and I think it will take a long time before the UK's behaviour will get to that level – it is more about behaviour than it is about anything else – if we could get people's behaviour

NN – but the design life of a building is so long that it takes a while before people can appreciate the impacts of the choices that have been made – we have had a heavy stint of trying to improve building performance through the building regulations and we still haven't really quite got up to terms with what the previous regulations where demanding but it obviously has to improve –

Me – how do you find your clients in terms of understanding all this sort of stuff?

NN – a lot of them have heard the word Passivhaus and we tend to work with clients who are quite enlightened and they would probably actually love to do Passivhaus but they don't really understand the details of what that make so it makes it harder in a way because you have to actually convince them not to do it because they don't realise what they are getting in to – the trouble is a lot of it has been kind of superseded by the code for sustainable homes and people obviously need to meet certain levels of that so they lose sight of other things like Passivhaus or the AECBs Carbon Lite system which has also been developed over quite a number of years and most of the jobs I have done recently tend to be more related to apartments and I guess people don't seem to see apartments in the same way as they do Passivhaus –

Me – that is weirs because obviously in Europe in cities you are more likely to have flats and here too –

NN – I lived in Germany very briefly but wasn't too aware of the Passivhaus standard – I think they are much more forward thinking in Germany than they are in the UK – so many of the things that we adopt over here are German standard things –

Engineers

28.B – Engineer / Independent Passivhaus Consultant and Trainer

B – Passivhaus buildings have to form as specified to work – of course they do that is a bit obvious – Passivhaus designs are future proof – that is the whole point – UK construction skills are appropriate, well they could be appropriate but they probably aren't – there is a market for Passivhaus – yes – use of MVHR improves indoor air-quality – yes – UK procurement methods work well to deliver Passivhaus designs – you must be joking – the UK has a lack of ambition when it comes to building low energy buildings – the UK is unaware I would say – financial incentives I disagree with it

The UK has a lack of ambition when it comes to low energy building design – I agree with that, Passivhaus will only catch on if the major house builders adopt it – sort of – UK construction types are appropriate for Passivhaus design – no they are not – the German name Passivhaus is appropriate for the UK market – don't care – PHPP is developed well for UK design scenarios – people in the UK are frightened by the high degree of air-tightness associated with Passivhaus designs – it is true – there are financial incentives to build Passivhaus designs in the UK – no there are not – the Passivhaus standard is well understood in the UK, no it is not – good communication between different members of the design team – you are joking – Passivhaus buildings are restrictive for occupants, no they are not – there is a mature supply chain for Passivhaus buildings in the UK, no there is not – the UK responds well to the Passivhaus German language product – our planning system supports the Passivhaus standard well – you are joking – we understand building energy performance well in the UK, that is definitely down the bottom end – UK current legislation favours Passivhaus design –

Me – can I just quickly ask you – you have the one you most agree with as Passivhaus buildings offer good comfort for occupants –

B – because I think it is the most misunderstood thing about Passivhaus is that in my view it is a comfort standard primarily – and an energy standard second and that is why it is so good and that is what we teach and I think that is the thing that people don't get – the problem is also that it is an experiential thing – until you have lived in one, you don't know what people are talking about – more comfortable, why what is wrong with my house? – The fact is you have got drafts and its freezing and it is too hot and you know – and you think that is good, well you haven't seen anything yet –

Me – the second that you most agree with, you have put Passivhaus designs are future proof and you have also put the use of MVHR improves indoor air-quality

B – and the whole point about Passivhaus design is that it is fabric first and it is dealing with the long term stuff – rather than pissing around and having to go and re-do the buildings in 20 years – forget the plant, we know the fuel is going to change or carbon intensity of the grid is going to change – so there is no simple answer for the services but there is a bloody simple answer for the fabric and we need to get on and do it – the use of MVHR – well people – if you haven't lived with it well how do you know – it's a problem I don't know what you do – I think you just need to get out there and build the things and particularly build them in housing associations – where we get a lot of people rather than millionaire house syndrome or even the owner occupier – well of course they are going to like it – they built it – it is their Passivhaus so you are not going to get any really unbiased feedback, but council estates – yes – they will tell you whether they like it or not –

Me – and at this end you have got – we understand building fabric performance well in the most disagree with slot

B – I am probably being a bit hard because there are little shoots of understanding appearing – crack in the pavement type of thing – Malcolm Bell particularly working with pointing out that here we are with all these regulations and modelling when the reality is that the average new building has probably got fabric loss 50-60% larger than the calculated one – so I think that the most key point is the realisation that actually we don't – even at the lower standards we are not achieving that

Me – why do you think that is?

B – basically we just haven't done any research – no money for real basic monitoring – no-one has done any large estates modelling since Altringham – and xx that is why the building industry has been getting away with crap really – crap construction – cos you can't see thermal, it is not easy you have to understand it and it is not visible from a fly-by visit – so you really have to spend some time digging

Me – how do you think that can be improved?

B – I suppose probably you have to get the message across to the politicians really – and get them to realise what a hole we have dug ourselves into – and also I think you have to move in terms of future legislation – Malcolm says very clearly that we need to have a feedback loop – which is based on the sites themselves, the builders themselves – we have and we were supposed to have that with air-testing but they seem to wriggle out of testing most buildings – I don't know how they manage that – I think that is probably something to do with the fact that we need to tighten up the regulations – I think we need to have developed some form of thermal testing – and Malcolm is saying one on fifty – I think you should be doing co-heating on an occupied basis – and test houses when they are occupied, less accurate but we get – to pick up these whether we are in the

right ball park or not – 60% worse on average and the best were 20% - the worse were 125% -- I mean it is just appalling really –

Me – there is potential that we are going through a sort of de-regulatory phase at the moment where things would be changed in terms of less regulation –

B – well I think the important point is for regulation that is actually useful – I am not a great believer in our current regulatory model with SAP and DER and TER – that has got such fundamental problems – simply that we know already that anomalies such as for some houses you need to increase the heat-loss area to get them to – the current methodology actually penalises good shape – there are loads of problems, I think the whole thing is pretty riddled which is why I work on Passivhaus and not SAP – why I have given up working and teaching on SAP – because I think it is fundamentally flawed and so I don't know what is going to happen in terms of the regulations, I am just keeping on doing something that seems like sanity and why I hope that the Passivhaus approach will gradually filter its way into what we are doing

Me – Is there anything you would like to say about the overall spread of the statements?

B – I think they are fairly good; you picked up most of the issues –

Me – you have strong links with the Passivhaus Institut in Darmstadt and you see how they approach things there

B – they look on with bemusement – especially wondering what on earth we are doing – here we are people clearly incapable of building any Passivhauses – til last year or so - clearly incapable of meeting the air-tightness standards and here we are claiming to do 2016 we are going to have zero carbon homes – it is a joke – they think we are peculiar – and I think they are right – it is just not linked to reality at all

29.Q – Sustainable Design Engineer

Me – I just noticed that you didn't go on to do diploma?

Q – because I didn't want to be an architect, I think mainly my decisions were based on talking to lots of other architects and them saying don't do this and I thought I have got to listen to somebody who is already there – also finding that I had a kind of real love hate relationship with it – I kind of adored doing it but found it kind of dominated my life – so I ended up kind of thinking that I can still work with what I am interested in without going down the route of detailing door jams - but what I am really interested in is making buildings energy efficient so I did the degree and thought I might just go and work in sustainable construction and on projects on site which is what I did then ended up here when – I never really thought that I would end up at an engineering practice

Me – it is interesting that you said you heard of Passivhaus in the US?

Q – that is where I did a lot of my work experience – I worked for an Eco-builder over there in Colorado and did a couple of internships one with a commercial eco-builder and one with building straw bale houses for rich clients – it was quite interesting really – there was a massive demand for that stuff and loads of people – his specialism was clay and lime plaster so he was always busy and he was always out working on someone's house every day or a different project somewhere – it was really really good and I was also working for a community that was started up and they wanted to build their own houses on this piece of land that they bought and when we used to have meetings with the architect – he was German by decent but living in America and every year he travels over to the Passivhaus conference – so he asked me if I knew about it and at that time I didn't -

Me – at this end the negative end, you have put Passivhaus buildings are restrictive for occupants and why have you put the UK construction industry has a fast-buck at the other end?

Q – because I don't think Passivhaus building is any more difficult to maintain or use or live in than any other sort of building and in fact it might even be better with maintenance, it is just a different sort of maintenance – so that is really quite clear to me and the other end – my experience over the last three years is that people are much more – the construction industry is really short sighted – unless there is some sort of financial incentive to be otherwise – or legal legislative incentive – at the end of the day people are just trying to make money for their businesses – and trying to please shareholders which is a bit of a shame really –

Me – so how do you think that could change – if it needs to change?

Q – I think it is quite a task – it is a mixture of users understanding what they are buying – most often buildings are not owner built so the consumer has to demand – but the consumer doesn't really understand – it is probably education of the consumer and then demand is there and supply

will follow – and that is just the way our industry seems to work at the moment – in an ideal world it wouldn't be like that – and people would make decisions for the right reasons – but everyone's values seem to be in the wrong place – organisationally values seem to be in the wrong place – it is all focused on money –

Me – you put some other things like – what would you say about anything you put in the middle –

Q – starting at the top – MVHR uses more energy than it saves – if it is used right, I would disagree – but considering most people once they are living in a building with MVHR have no idea or can't be bothered to change filters I know it can swing – it just depends how well they are used and how well they are understood – is there a market for Passivhaus designs in the UK? I guess there definitely could and should be a market – kind of in relation to going for renewable technologies the legislative framework is highly favourable to renewable energy technologies – and so that is chosen in place of reducing energy demand in the first place which is sort of leading to lots of other problems because renewables are all good but we still don't seem to know how to use them – they can end up being mis-used or you can end up not designing low energy buildings – so procurement methods, I put that there because I don't really understand procurement methods – so I am not sure where to put it – communication between construction trades similarly I expect it is not very good but I don't know – the UK government only looks to the BRE to develop building standards – again I am not entirely clear on that – we understand building fabric performance well in the UK – I think no but we are quickly understanding it better – but I know I probably come from a biased and I work in a building with a bunch of people who understand it more than most so ...I expect that we don't but I am sort of seeing that – and then PHPP is developed well for UK design scenarios – as I understand it essentially it can work pretty well and then I know there are some people who say you don't need triple glazing in the UK and maybe the standards don't need to be so extreme as they have to be for other countries that experience a lot of colder temperatures so – whereas I think it would function perfectly well, I don't know if it needs to be

Me – is there anything else that you would like to add to that?

Q – I think there needs to be something in between SAP and PHPP – because PHPP doesn't seem to be very user friendly – and it is quite laborious – but SAP doesn't seem to be detailed enough – I think the code for sustainable homes and Passivhaus are just two different things – completely different things and quite often people compare them against each other but these one or two elements in the code for sustainable homes where one draws parallels and I think they are completely different whereas the code won't actually tell you how to achieve a very good energy standard whereas Passivhaus will so but yet again I think that that is one of the big mis-understandings it seems to be people's view in industry is that – I think there is this mis-understanding that why would you need Passivhaus if you are doing code – and why would you need code if you are doing Passivhaus and some other completely different things and some

people don't seem to understand that – and with construction skills and design skills I think we probably have the capacity to design it more than we have to construct it

30.T – Building Services Engineer

T – understanding buildings – understanding building performance well in the UK well some people understand building performance very well but I think maybe a number of people don't as well – overall we need more building physicists – people and adoption – I think people are scared away by the cost or the perceived cost and perhaps lack of kind of building skills so maybe they are not that ready to adopt but some are – the code for sustainable homes is a better standard than Passivhaus – I don't think they are directly comparable – so I think that that is very difficult to say – its better, so I suppose I should disagree – appropriate is a difficult word for new and refurbs – I have heard that there have been refurbs done to Passivhaus standard but again they did seem to be quite expensive for the amount of carbon saved which isn't to say they won't get cheaper over time – MVHR uses more energy than it saves well it depends on the building you install it on – it could be – if it is a sealed building then fine, if it is leaky then it is silly so – UK construction types are appropriate for – PHPP is developed well – I don't know so much about PHPP so – people in the UK are frightened by a high degree of air-tightness – I think they are – the planning system – the planning system in London drives quite high sustainable building standards – not necessarily Passivhaus but quite high efficiency, but our evidence suggests that after a certain improvement in energy efficiency the graph is zooming up so it is quite high cost to get close to Passivhaus standards so I am not sure it supports Passivhaus standards well – Passivhaus buildings are difficult to construct well it depends on the skills you have got in the labour force and experience but in the UK I think we lack some of the skills and knowledge so I think we probably are – Passivhaus are future proof, yeah I think they are quite future proof cos at least you can add on some renewables to get to zero carbon but then you have got a good solid core built in – so that sounds like they are – the use of MVHR improves indoor air-quality – assuming it is set up correctly – it can be a much higher air change than a normal building – Passivhaus buildings have to perform as specified to work – to perform as specified to work as specified, to work – yes that is almost top because we would certainly say that you can have a super-sustainable building designed and you can even have a super-sustainable building but it is all about how the person or how the people use it as to whether it is effective – can work well with UK building aesthetics – they probably can – Passivhaus designs are too expensive – that is the sense I get – it will only catch on if the major house-builders adopt it well if you want wide-spread uptake it does mean that you need the major house builders or in the residential sector at least – do we understand building energy performance well, relative to who? – I think we are getting much better but – and a lot of the applications we see, they have to because they ask for lots of information and they use consultants who specialise in energy modelling so – there are the people out there if you are forced to or encouraged to use them

Me – are you happy? – I am now going to ask you why you put that one at the far end of the negative end as in Passivhaus components are affordable in the UK and also why you have put that one – Passivhaus buildings have to perform as specified to work right at the top

T – the impression I get is that one of the major obstacles to Passivhaus in the UK is cost and there is a scheme up in Islington here and they have had to bring the whole package and design expertise in from Germany lock stock and barrel so I think supply in the UK is very difficult as yet and this may be one of the biggest obstacles – I know the Welsh are looking into building a factory or something advanced – and in terms of most agree I think that even if you have a very well designed Passivhaus and it is built and it is measured to perform to the highest standard – if the people who then use it don't clean the filters on the MVHR or run around with the windows open or do the rebound effect and turn the heat up anyway then it won't be very energy efficient

Me – what about stuff you put in the middle – have you got anything you would like to say about that?

T – I think that is just me sitting on a fence – design skills yeah I am not sure about design skills – I suppose since I have said that, I think we do have a good understanding of fabric performance maybe that is erring towards we should be able to do that – the Passivhaus standard is appropriate for new and refurbs – I think I would struggle to define appropriate so I guess it would come back, particularly to refurb to cost effectiveness of refurbing to Passivhaus standard – it would depend I guess on the specific refurb – and the option you had – MVHR uses more energy than it saves – it depends on the building fabric and how it is used – PHPP is developed well for UK design scenarios – I am not very knowledgeable about PHPP use – I think someone at Kings College is playing with it? UK procurement methods work well to deliver Passivhaus – I am not sure I have got a strong view on that – I don't see why they would necessarily work against Passivhaus particularly as opposed to any other construction method except perhaps sometimes in terms of problems with supply lines and skills – are they restrictive for occupants – I know that there is the sense that or idea that you can't open your windows – so I suppose they are perceived as being restrictive but I get the sense that maybe that is a bit over-egged – and you are probably going to be tending to open your windows in the Summer time when if you are opening your windows then the heat losses are not going to be as great – it is not going to be having such an impact on the efficiency of the system as if you would be opening them when it is minus 5 outside all the time – and is the name appropriate for the market well I wouldn't have thought it would necessarily put people off – I don't know I am not a marketer –

Me – is there anything else you would like to say

T – it is very difficult and I feel like I am being forced to make fine distinction which I am not sure would stand up in court or if I came back and – the impression I get is the kind of financial and the

skills and the general kind of knowledge and awareness of the standard – why what the approach is and how that compares to doing a little bit on efficiency and then kind of bolting on lots of kind of eco-bling and saying that is a sustainable building – I wouldn't have thought necessarily that they had to be high embodied energy because I am sure that you can do various clever techniques with timber frame construction and so on – presumably it would be easier if we had Passivhaus in the English language – again if there was more evidence to show that you could build Passivhaus at affordable or more affordable build costs then maybe readiness to adopt would increase but I get the sense that is the big blockage – although having said that more people – we have been running a housing design competition and quite a few of those – we ask them to aim for code 5 but most of them have adopted Passivhaus or near Passivhaus as an approach

Me – how far is that in progression?

T – we have got down to a short list of three designs I think – the winning scheme will be built and potentially some of the others – this is just up near Finsbury Park – there is an identified site but I wonder if once they get their real energy guys on board then they start looking at the detail then they will suddenly realise that actually they might have to have a bit of a rethink on various things but certainly at the moment they are talking Passivhaus or close to as an effective way to – and I think that unfortunately a lot of developers are primarily financially driven, although not all and I think there is an education element generally perhaps for the public because we tend to see all the press around turbines on houses and solar panels which is all fine up to a point but thinking about the levels of insulation that Passivhaus is talking about is effectively the idea that you can have a no heat house.

31.U - Engineer

Me – how is work?

U – incredibly busy because the fees are lower and we need more projects than we used to have to cover

I don't know if there are financial incentives but there is not much financial incentive for low energy building schemes anyway

Me – it is like in Germany the KfW bank provide

U – Oh special support

Me – but some people see the incentive here as being the fuel cost saving

U – My impression is there is not a supply chain in the UK but – the code for sustainable homes is a better standard than Passivhaus, I mean it covers more things – do you think they meant that on an energy performance or precisely do you mean in terms of energy performance or the overall standard? –

Me – I think that is for you to make a judgement

U – the indoor air-quality one it depends so much on if you have your exhaust away from the road yes and if you are comparing with residents who would never open the window yes – so as a general statement I disagree with – the UK has a lack of ambition – I disagree with it because of the whole refurbishment situation of the new build but it is – but in terms of refurbishment I don't think there seems to be much ambition at all –

Me – you think there should be much more ambition in terms of refurb?

U – yes – for example where we have schemes when we are working on large amounts of money say people expect code level 4 on the new build but then nothing to be done on the remaining refurbishments – it is just ridiculous

Me – is that because of their lack of understanding of how things are performing or because

U – yes there must be a bit of a lack of understanding – and the planners are not necessarily technically minded enough – and trained so they won't be able to know whether what they are accepting conforms with the general emissions or – it is complicated – refurbishments are obviously going to be more complicated to do – I think it is a scandal to spend so much on bringing say a new build to code 3 or code 4 and you are doing nothing next door – for people who are going to live next to each other – there is so much incentive for loads of new panels – I am trying to refurbish my house and I think I am reasonably technically minded and I am clearly not the worst

off and I am scared by the amount of money and by the lack of skills – we are trying to get but it just seems to be incredibly difficult to find – people need a lot of money – there are a few flashy examples around London of refurbishment – but that is Camden, lets splash a million pounds – and people who say they have insulated the fabric to Passivhaus standard that is not the case what they figured out is that they couldn't insulate the external wall well so they built an extension – so the new build, the new wall is Passivhaus standard – you can't have examples like that and present it as this is the only way to improve your house – there must be a middle ground

Me – so how do you think you would get those examples of an affordable refurb?

U – there seems to be one or two now going on but most of the examples I have seen are well off couples – usually without children who seem to have a lot of money – its great but it just makes you feel like if you can't go all the way you can't go anywhere – and I don't have a loft and especially for Victorian fabrics – you see people going for non-permeable insulation – you don't want that – there is an incredible lack of dissemination about this – it's a bit weird

UK construction types – I think they could work quite well actually because there is more and more – we tend to work on larger projects but clients tend to look more and more to off-site construction – so probably for these you could achieve good levels of air-tightness and better detailing if everything is done – I don't really know to be honest – I do not see the German climate as that much different from the UK climate – it is not that I think that MVHR works to improve indoor air-quality it is just that it is site specific –

With renewables I am not sure with the general public because you have low energy light bulbs perhaps it is sexier, you can see it but it is maybe less so now with designers – and amongst the educated planners – but there is still in smaller planning authorities and systems – there is renewable energy, partly due to all the planning policy statements – they are not that flexible and I guess that it is a vicious circle because if you are pushed to put a PV panel in a BREEAM excellent building then to get to BREEAM excellent there will be loads of measures but the one that will be talked about in the press and in the planning consultation is the PV panels so people will say oh it is a BREEAM excellent building and it has PV panels – the government has supposed to have moved away from it but if you look at the financial rewards they are still much more accessible for plug-on on-site renewables than for anything else – and I guess the big thing not talked about here would be district energy – which we would generally try to advocate on suitable sites and which can be misunderstood I guess –

Me – and what about the statements in general – do you think they cover a broad range of the issues or do you think there is anything missing?

U – I think they cover all the issues that I thought of – there are a couple associated with the MVHR – it is going to be so specific – I mean MVHR uses more energy than it saves, I guess that

means if it is used properly – I do not agree with it if it means people will still open the windows and have the MVHR running – I personally have a bit of a problem with MVHR in residential buildings – because it means that a lot of people would have to fundamentally use their apartment is a different way and I am not sure that it is always well explained and it might be on the day that the house is delivered but what about the second buyer? – or the third buyer or so in an office or in a school maybe – I don't have much of a problem but personally I like a breeze through my house – if it is cold it might just be for a few minutes but I like it – I like hearing the birds also and I have always lived like that so – in residential buildings I don't know –

Me – what about the middle ones is there anything you would like to say about those?

U – SAP and PHPP – I don't know about it, I know that basically there are people who criticize both so – a few months ago we tried to use Minergie and there were lots of – I mean it takes time for you to work out exactly what they mean by such things – how cooling is accounted and what assumptions they have made on lighting and it does take a while and I guess you would really need proper training because people might just coming from SAP use PHPP with certain assumptions that are not necessarily appropriate but are but I really don't know PHPP – the German language product – we understand building fabric performance well – again I am mostly thinking about refurbishment where it is not really the case but for new build I don't really know – UK current legislation favours Passivhaus design – for new build it favours low energy buildings but whether that is exactly appropriate to Passivhaus – I guess if you have got to the levels of Passivhaus performance it wasn't really reflected in SAP and therefore in that case the legislation might not favour it well because you might not get that benefit by getting a much better EPC certificate – building design aesthetics – I can see no reason why it shouldn't – I think the biggest issue here for me was MVHR –

Me – are you working on any residential projects at all?

U – yes if you want to get to code level 4 then you don't really have a choice – and I don't think there are many built flats or houses with MVHR so I would like to see some results – I don't know if there is much monitoring – I guess if people buy a low energy house I guess they are interested in low energy design so they would be interested but typical MVHR development –

32.V - Engineer

V – I don't want to agree on something whole-heartedly when the design would relate to a specific house – they can still be designed in different ways can't they

Me – absolutely

V – I think some Passivhauses are appropriate for the UK climate and some probably aren't –

Me – how do you find working here?

V – coming from Denmark where it is a bit colder and we have had insulation standards for a bit longer and working here is roughly the same and things are picking up quite a lot – but living here is something else because the houses are colder even though the climate is warmer and I am not used to draft and I have to sit there with a blanket on and I am cold all the time and that must affect the energy consumption as well and we have got radiators and the whole electric heating everywhere and we've got electric heating and we live in a housing complex of flats and in Denmark that would always have a central boiler room in the basement somewhere – so each flat has electric heaters and each flat has a boiler – with electric boiling system and it is just that

Me – they have probably got single glazing

V – actually ours has got double glazing but it wasn't born with it – it is just weird that so much space is taken up by it as well – because there is a couple of good square metres where the boiler is – that could have been put in a basement somewhere where no-one has to go and the boiler engineer would only have to come out and look at one boiler if something – all these things it just doesn't make sense and electric heating –

Me – yes I think there is a problem allowing enough plant space and they cut the actual size of the accommodation as well

V – yes we lose a couple of good square metres to a boiler room or cupboard that could have been put into a bathroom or and it is just odd and I feel bad every time I turn on those electric heaters and they call them storage heaters but it is still not great –

Me – and you say there is not much difference working here but what about dealing with clients and their understanding and knowledge of energy issues

V – I think it is a different approach a lot of it so sometimes it is hard to say – it is not ignorance or not wanting to do something but it is also to do with lots of habit there are other ways of doing things obviously that might be just as good – and the climate again is different – it is a lot colder where I am from so – I think there is a lot of good will – lots of people want to do all of this which is all a very good starting point –

Me – in terms of air-tightness and draughty buildings people in other parts of Europe have been building to higher specification for much longer

V – yes – I do not know why that would be – all the new houses in Denmark are built with a little valve in the wall basically for fresh air intake – you see them in the window sills sometimes as well – but other than that that is all you need – that is enough for – but I don't know why it is such a problem that they are air-tight – it is something psychological it is hard to understand – for me at least – well it must be a feeling of claustrophobia or something –

Me - I am just going to ask you quickly about what you have put down on the chart at the negative end as your most negative one you have put the UK has many existing Passivhaus buildings to learn from – have you ever come across or seen Passivhaus buildings in the UK

V – I haven't visited any no –

Me – and in terms of Denmark – you have been in some in Denmark?

V – No but I have worked on a couple of projects – but they were desktop projects at the initial design stage – I left the company before they were getting built –

Me – and then up at the other end with the ones that you most agree with – you have put Passivhaus buildings have to perform as specified – but at the same time you are saying that they offer good comfort and you think that there is a good communication between different members of the design team – would you like to say more about that

V – well all that this is saying is that they have to perform as specified which I think is self-evident – but these say that we are actually able to do that because there is good communication and this the fact that they perform as specified well they are always built to have good indoor climate and so I would say that that is self-evident that they would have a good level of comfort and they would have a good level of comfort for occupants and I think as well that some people might feel restricted – by various things and I think that a level of information or education for occupants would probably be necessary – but that is nothing to do with the comfort but in my view it has to come with something because well all buildings should because it is very easy to use them in the wrong way –

Me – going back to your Danish example of a typical block of flats – who usually deals with maintenance of that?

V – well there is always a superintendent who would deal with that – he would call out someone that the building uses to fix it – he wouldn't fix it if there was something more wrong than just – he can do small repairs the washing rooms and the plant rooms and all that and if there was

something major, he would on behalf of the housing association or building association, he would call someone out –

Me – so would you have the same situation with a completely privately owned block?

V – You would still have that – unless of course you were in a private home like my parents who live in a bungalow and they have got their own boiler – and they have to call someone out themselves – they don't have someone that their housing estate uses –

Me – cos one of the things that people talk about with Passivhauses is changing the filters – and there are lots of developments in Germany and Austria where they have maintenance contracts with people and it sounds like you could have similar systems in Denmark

V – actually I don't know how things work where I live now cos things get sorted – I mean we are renting but they are owned flats – things like the lighting in the hallway got changed recently and someone must have contracted out and paid for that out of – so there has got to be something but there is not this superintendent who comes round and sorts things – the boiler got fixed – not on behalf of us – it got updated so someone called someone who just rang the doorbell and said I have come to update the builder – so there are some – someone must be on the case

Me – what do you think about – do you have much experience of that sort of thing going on here? Like in commercial buildings and schools and people in the UK are very worried about the maintenance of kit and that that might not happen

V – I am not sure that we have it in our block but somebody must have been because as I say they updated our boiler and the lighting in the hallway so there are things going on – but in Denmark there is a number to a superintendent that I can call if my toilet has stopped working or something – whereas here I have to call my estate agent

Me – is there anything else you would like to say about this general array of statements

V – well up here I have put something like we have the skills – cos I think we do – this I see – Passivhaus needs strong and coherent representation in the UK – needs I don't know – if we want to use this particular set of rules then it needs coherent representation – it is not to say that there are not different things that could also be implemented – which could be just as good – but the fact that it is already up and running is an advocate for use – again as I said earlier – I have put some in the middle area because I think that – is it appropriate for UK climate depends on how you use the technology and the possibilities within it – and then on the down-side – I have put I don't think it is restrictive for occupants – if users understand how to use it and if they are taught and it can be built in many ways so you can't say as a fact that it is just restrictive – I have put down here there is a mature supply chain for Passivhaus components – I have put it as a negative but then again – there are components that could probably be used they are just not labelled as Passivhaus and

then there are these things that sort of allude to the fact that Passivhaus is German and then therefore might not be popular – we are all human and maybe not because it is German but because it is foreign that might pose a problem – so I do agree with the fact that we are not all professionals and we are human and if there is a UK standard we work with that –

V – People work with Passivhaus in Denmark more than here because there isn't BREEAM or LEED or anything like that

Me – has Denmark been affected by the financial downturn as much as here?

V – Not as much – cos I think the English economy is more linked to the American – we are probably more connected to Germany and Europe and all those centres –

33.W – Engineer and Passivhaus Designer

W – I think a lot of things have changed because we are getting things built and the level of fabric efficiency is improving – and understanding fabric efficiency is improved a lot – gone are the heading days of the renewables only approach – the people value insulation and I think the code is going to change and things like that – it has moved on quite a lot really in the discourse – and there is major commercial projects being built rather than one offs – and we are still in the one off phase – and fingers cross two of our inbuilt projects will be signed off and that is two 14 house social housing schemes – and another 23 house social housing project – they are both on site the Wimbish scheme is going to complete in March (2010?) – and the Samson's close scheme I believe in February –

Me – how was your visit to the Passivhaus Institut?

W – it was good – really interesting – you learnt a lot of stuff which isn't in the books – which was a bit both daunting and useful – if you are half way through a very large project and you find things out and think ...so I think the more the Institut communicate with people designing Passivhauses the better –

Me – do you think they are good at communicating or just over-worked

W – they share what they know – compared to how they probably should be to encourage people there is probably a lot more work to be done – they are making the changes but they have got a whole world to train up not just the British – yes I am a big fan of them and the way that they work – the ethos

Me – how many are there?

W – it is about 20 in the research institute and there is Passivhaus dienst – which is for certification which has about another 30 – so they are pretty big and they have got the information group which is growing as well but they are primarily a research institute which is what people don't realise as well and the PHI itself are not a service provider and they happen to be a very enlightened research institute that wants to spread their ideas – I think that the reason for its success is down to leadership and when you are there you have this very strong leadership and the reason it is successful is because it works but also down to the leadership – and even down to the way that you become a certifier to act in their name – they have got to know you personally and that is when you pass or fail – it is down to your integrity –

Me – Witta was very keen to stress how much they had done it all on their own and without government support

W – Or little government support – it is a private research institute it is their personal

Me – do you think we have got anything equivalent in the UK?

W – I am not sure that we do – the place to look would be at social enterprises that are innovating – social care provision and environmental improvement because that is where there are the nearest links and the Universities here are really dealing with industry and those industrial links that they have are at the highest level funding driven so in terms of disseminating by doing – they are not very good – they are a bit far off and they always partner with the biggest organisations in the field and consultants etc. whereas what PHI has done is it has grown very much from the grass roots – research lead but grass roots driven – and they actively use the internet to spread their ideas as well –

Me – do you think things like that could happen here?

W – yeah – I think they could and I think they are – there is lots of on-line innovation going on – I don't think there is that kind of innovation in the construction sector necessarily – I think there is definitely a space for those kinds of things still – the industries are quite different – housing is largely a component design – the industry is much more fragmented than say car design – people have tried to launch open source car designs and spread them but they have just never been successful – people's supermarket is possibly a good idea -

34.X - Engineer

Me – you say you have got more disagreements?

X – yes I am struggling to find more that I agree with and enough to fill the minus three – I have still got way more than half on the below zeros – I probably need to skew my whole thing around – my neutral ones might have to become plus ones

Me – are you happy with that?

X – Yeah I think overall – there are one or two where I was not sure where they went around neutral – but I think overall

Me – you have got we understand how to detail buildings well in the UK right at the negative end and up here you have got that the UK construction industry has got a fast-buck mentality in that you really agree with that – would you like to say a little bit more about both of these in relation to your experiences of the industry?

X – In terms of trying to achieve a good end building performance my perception is that you need to pay a lot of attention to the basics and the detailing and I think that is something that there is not a lot of focus on generally in the professions – particularly in the architectural profession certainly in terms of energy performance – and just from my perception really and there is not really much encouragement from the clients either because it is more about how it looks and how it is going to sell – not necessarily about how it is going to perform in 8 years' time – whether or not it was robust and whether the seals were going to deteriorate or even be air-tight in the first place so I guess they are linked

Me – what about the stuff you put in the middle you said some of them are kind of similar?

X – the ones that I am mostly neutral about because I had more of an overall disagreed with my more neutral ones tend to be between zero and one rather than just in the zero – there were a couple which I didn't really know how to answer because it depends on how you, what you are comparing it to

Me – which ones?

X – which were things like – there was one about the German – Passivhaus German language product – if everyone responds well to it, I am not quite sure what that meant –

Me – there were a lot of issues which were brought up in discussion – a lot of literature maybe 99% is in German

X – it is just a simple fact that the product has a lot of German – things like it being flexible it is just how you might interpret it – you know like whether it is flexible compared to what and all those

sorts of things and I think it allows for flexible use of a building but the standard itself might not be – there was one particular one where I thought it really could be interpreted – it was this one – the Passivhaus standard would only catch on if the major house builders adopt it and that would depend on what you define catching on to be – if you mean that 85% of homes have it then yes you would have to have the major house builders – but if catching on is defined by ten a year then no you don't –

Me – and just a little bit more towards the other ends of the scale – back to the negative and the positive in the two categories – the UK has many existing Passivhaus buildings and Passivhaus standard is well understood in the UK – and what is your experience?

X – my experience is even in the relatively specialist field of energy consultancy and people who do look at the early stage standard setting – most people now know what it is but I would say I don't know that much about it but I seem to know more than most people I come into contact with so I would say that that means it is not very well understood – because I know that actually when you interrogate someone who professes to know about it well you know less than I do and I don't think I know that much – it's like that with most things in the energy consultancy industry actually – and there is not many examples – when I was doing the thing that I was doing there were very few examples that were fully constructed and so again it is something that is banded about as a word a lot but actually it is not followed through much

Me – and at this end you have put that you really agree that people are frightened by the high degree of air-tightness – and also that Passivhaus needs strong and coherent representation in the UK –

Me – yeah – I guess the air-tightness thing is just linked with the opposite of the skills stuff – and I think frightened and or don't even understand – the strong representation I think exactly the sort of mirror of it not be well understood – it would need stronger representation and I think the coherent thing is the most important bit because I think people now are familiar with the word but they are familiar that it means low energy – they are familiar with that it means – they are probably also familiar that it means a high standard of insulation and air-tightness – but what it actually manifests as and how and what skills exactly or not – to actually implement it I think the coherency is actually taking it beyond the buzz word or the banner –

Me – this is a whole cross-section of statements – do you think that in your experience that that is a good representation of issues that could face the uptake of Passivhaus?

X – I would say that my perception is that the issue of the difference between the specification and that I described within Passivhaus – and overall Passivhaus labelling – maybe that is one thing that I think would be – I don't think it is a major issue but it is one of those things that will become a major issue – as people are asked to do more of them – perceptions of maybe the certification

process versus a building that has actually performed in that way and maybe – there are a certain set of ticks and boxes and the general excessive number of tick boxing we have to do – so I think that is an issue that has not really come out but that is not really – I doesn't take away from anything here –

Me – is there anything else you would like to add?

X – no as with most things around agreed building performance – the sooner that we can get to grips with and implement what is a relatively simple set of considerations – the cheaper and easier it will get – from my experience with a lot of major house builders – whilst the actual cost per unit per metre squared of an item is an issue – it is actually the unpackaging of the whole supply chain and the way it can be built cheaply and delivered to standard – that is more of the stopping point as opposed to necessarily the exact materials – kind of cost and it is that our people doing costing in the UK don't necessarily acknowledge that – because they look at things on a unit rate and its like that piece of insulation and that wall on a unit rate basis – and it is going to cost you a lot more whereas when you look at house builders – they are surprisingly a little bit more holistic in their view of things and you can explain the overall construction process and skills and how they can work out the overall construction process to be not that much more expensive, then they are more likely to take it up – effectively I think it is their lack of experience of the brass tacks that give them more fear than is often warranted

35.Y - Engineer

Y – I think in Germany people are more geared towards self-build and the UK planning system really doesn't promote self-build – they don't seem to like these individual people coming along with their own designs – so if that was changed I think a lot more people would build to this standard –

Y – Clients are ready to adopt it they don't even know what it is

Passivhaus German language product what's that

Me – most of the literature is in German – we don't seem to have worked that out yet that it would be a good idea to translate it

Y – We understand how to detail buildings well what is that in design or construction

Me – both

Y – Design detail there is possibly better understanding – Passivhaus is developed for UK design scenarios – I don't actually know – we understand building performance well in the UK – we understand it but we haven't got the data – Passivhaus will only catch on if the major house builders adopt it? Yes – People in the UK are frightened by the high degree of air-tightness associated with Passivhaus design – come on do they even know what air-tightness is? –

Me – ok you have put that one at that end – why have you put that people in the UK are frightened by a high degree of air-tightness? – You really disagree with that?

Y – I just think that the person who said that has a very optimistic understanding of people in the UK's understanding of people's attitudes to their houses and that they understand how they work beyond the door opening and the tap working

Me – and down at that end – fast-buck?

Y – yes there is no – it is basically quick in and out – it therefore doesn't allow for any long-term legacy to evolve – if anything presents a risk or is new – centralised house building predominates in the UK that is one reason we have so few examples –

Me – you have put here that Passivhaus needs strong and coherent representation

Y – yes there are so many different types of eco-construction and one off exemplars but they are not going to make it to the mainstream unless the industry adopts it on mass – so zero carbon came out before the government announced it and when the government announced it the Green Building Council co-ordinated that and now it is an industry mainstream terminology and thing we can work towards – unless we get critical mass I don't think it is going to happen – everyone

concerned needs to understand it unless planning officers unless contractors – so it really needs to get that critical mass so it is spread to all different people – and there is a construction process up and down the supply chain so they know what they are dealing with –

Me – what have you got over here –

Y – these three here – the fact that we haven't even translated the stuff into English is why you need strong and coherent representation – because no one company is going to do that off their own back – like the Sustainable Design Foundation or the Passivhaus Trust – we need a body to translate the manuals then we might have some more exemplars – Passivhaus again most people are frightened by the high degree of air-tightness – again I don't think most people know what Passivhaus means – it could be a German surname for example – rather than actual design terminology – so I think it actually needs a certain – UK construction industry has a love of branding – eco, green, eco-town you have had a type of development name tagged on to something – it means nothing but if you call it eco-green it creates a market – in terms of the supply chain, I don't know enough about Passivhaus to know what components it needs so I can't really – because there is not much of it in the UK – I doubt the supply chain is really set up – and most people don't really understand it – I think that is an instinctive guess – some of the ones in the middle are not because I agree or disagree but because they are I am not entirely sure, they could be either way – I don't know enough of the detail – the code for sustainable homes well Passivhaus is good but it is just an energy standard – the fact is that it is flexible, the fact that we have got zero carbon targets – we need small exemplar developments of say 10 houses so they could understand how to build this up to mass scale – the German climate is not hugely different from the UK, I can't see why it can't be adapted – the Germans can live in it why can't we? – Passivhaus designs work well with UK building design aesthetics – actually I should probably put that in disagree because I think people just love the Victorian/Georgian – two up two down aesthetic design – and Passivhaus is generally a little bit more quirky modern than that as far as I see – although it can be adapted to the two up two down kind of approach – there are no financial incentives for energy efficiency it is all for renewables – so that should be more to the disagree side – I don't know how difficult they are to construct it is just that – eco-labourers do what they know best and stick to that -